ORATION,

&c. &c.

TO

J. C. LETTSOM,

M.D. F.R.S. F.A.S. &c. &c. &c.

PRESIDENT;

TO THE

COUNCIL AND FELLOWS

OF THE

Medical Society of London;

THIS ANNUAL

ORATION,

PUBLISHED AT THEIR REQUEST,

IS DEDICATED,

BY THEIR

FAITHFUL SERVANT,

RICHARD SAUMAREZ.

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INTRODUCTION.

The council of the Medical Society of London, having resolved, that I be requested to publish the annual Oration, which I was appointed to deliver; and this request having been urged by many Fellows and Auditors present; I feel it a duty to obey the resolutions of the one, and to comply with the wishes of the other. It affords me the opportunity of presenting to the public, an analysis of a few of those important subjects, which I have amply detailed in other works. The power, the nature, and the ends, of life, or vitality, are so little understood, and have been so shamefully outraged by Richerand, in a Physiological Book which is in general circulation; that I have deemed it a duty to expose the wicked

tendency of his opinions, and to put the subject on its true foundation,—briefly, it is true, but, I trust, explicitly.[1]

After stating what I conceive to be the nature of life, and the properties of living matter, I have proceeded to investigate the general and particular nature and attributes of matter, dead and common; from physiology, I have descended to physics. In exposing the errors of what I conceive to be an unnatural and artificial system, and in giving new principles to old facts; I have felt the hazard of an undertaking, which I meant to be as a sort of protest, which one individual entered against the mass. Although a few months only have elapsed, since that Book has been published,—the plain and palpable matters of fact, which are therein stated, and the deductions I have made from them, have not

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[1] Those who wish to see the application of those principles to the process of organisation, and the whole system developed, in the functions of organic life, both in vegetables and animals; may consult my New System of Physiology, in two Vols. oct. 2d Edit.

only staggered some of the most incredulous, but been the means of making converts of many of the most bigoted. The *analysis* of my opinions respecting the physical and natural properties of air, which I have given in this essay, will form a sample of the manner in which the other subjects are discussed.

The great objection which I entertain against the present system of natural philosophy, arises in the false analogies that are made between bodies, whose nature and properties are totally different from each other; in the false facts, that are assumed for principles of physical science,—in the practice of making matter of different species, amenable to one and the same law, and throughout the system of nature, postulating and demanding a condition of things, which in nature does not exist. It has been owing to this successful attempt, that we have been called upon to believe opinions, that are not more revolting to the feelings, than they are to the good, common, unsophisticated sense, and apprehension of mankind. Amongst a multitude

of other things, equally erroneous, it is affirmed and assumed as a fixed principle that,

1. Instead of matter in general, being essentially different in its nature; instead of supposing that the particles, which form the solid and fluid matter of our system,—that earth is different from water or from air, and all of them different from fire and from light; it is on the contrary assumed, that the primary particles of matter throughout the whole system of nature, are solid, massy, and ponderable.

2. Instead of these different particles being admitted, as we behold them to be, *penetrable*, not only to the active powers of life and of sensibility; of light and of fire; as well as to a variety of other chemical agents,—it is absolutely affirmed, that the *softest* bodies, are equally *solid* with the hardest; and all of them *essentially impenetrable.*

3. That notwithstanding this pretended impenetrable quality, inherent in the primary particles of matter; it is supposed they, nevertheless, possess

powers of attraction, in proportion to their quantity; that by virtue of this power, one mass of matter acts upon another mass, and both upon each other; not only by immediate contact, but independently of it,—not only where it is, but where it is not; that these imaginary powers, subsisting as causes, produce effects at the most remote parts of the solar system that can be conceived; which effects are manifested by the motions the different planets display, of which the system of nature is composed.—As well might it be affirmed, that *something* might be produced out of *nothing*, as to say, that a body can act, where it is not.

4. Although every fact, which we possess, goes to prove, that every particle of radiant and ethereal matter,—of light—of fire, and of air, is repellant and expansible,—imponderable, and absolutely destitute of gravity or weight: it is nevertheless affirmed and believed, that the sun, this source of radiant light and of repellant fire, forms the attracting centre of the whole planetary system; and that it is by the *attraction* of *gravitation*, that the different heavenly bodies are dragged and pulled down towards it.

5. Instead of supposing that the atmosphere, by which this globe is enveloped, is formed by the chemical agency of the solar rays acting upon the solid and fluid matter of which this globe is composed; (independently of other subordinate causes) it is on the contrary supposed, that the aqueous matter, which covers, to an unfathomable depth, two-thirds of the surface of the earth, exclusive of that large portion, which constitutes rivers and lakes, and which is kept suspended in the regions above, in the form of atmosphere and clouds; is an effect produced, by the combined union of two *factitious* airs or gases, each of which are more than 900 degrees rarer than the same given bulk of water;—thereby admitting that the *effect* is greater than the *cause*.

6. Instead of supposing that the atmosphere is *generated* at the earth's surface, and expands to the uttermost points of elevation, by virtue of its expansive force, becoming rarer and weaker in consequence of increased dilatation; it is on the contrary affirmed, that the atmosphere is generated in the regions above, and increases in density from top to bottom, by virtue of its weight; similar to

a bag of wool; and that the pressure which the atmosphere exerts, is the pressure of gravity or weight, which at the surface is in the proportion of 15 or 16 lbs. upon every square inch.

7. Although all fluids of *equal density*, subsist in a state of *equilibrium*, pressing as much as they are pressed, and resisting as much as they are resisted,—that the most flexible bodies, are immersed in the ocean at a depth the most profound, without bending; the most elastic, without re-acting; and the most expansible, without bursting; —it is nevertheless, presumed that fluids press *in proportion to their perpendicular height*.

8. Although all bodies which contain the same quantity of matter within the same bulk,—are in a state of equilibrium or balance; it is nevertheless supposed, that all bodies are absolutely heavy.

9. Although rare bodies have as great a tendency to rise, as dense bodies have to fall—that the gravity of one body, is consequently relative to the levity of another,—it is nevertheless sup-

posed, "that no bodies really light are to be found; that what is called, relative levity, is not true levity but apparent only, and arises from the preponderating gravity of the contiguous particles, insomuch that all circumterrestrial bodies gravitate towards the earth."

10. Although the gravity or weight of bodies continues to increase, in proportion as they are removed from the plane surface, to high points of elevation, or as the rarity of the air from the earth *increases;* or in other words, that a body weighs *less* near the surface of the earth, and *more,* at a distance from it; it is nevertheless affirmed, that the attraction of gravitation *increases* in proportion as the squares from the surface of the earth decrease.[1]

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[1] Although this fact falsifies the latter assertion, this assertion, nevertheless, constitutes the fourth law of nature, as it is called, of Sir Isaac Newton's system. It has arisen from that false philosophy, which delights to take false facts for principles of natural philosophy, and which consequently confounds *motion* and *weight* together.

11. Although the gravity or levity, which different bodies manifest at different times, are effects which are generated and produced, by the change they undergo, in consequence of the relation which they bear to the medium in which they are placed,—a vacuum, or space without matter, is nevertheless assumed.

13. Although it is a demonstrative truth, that whenever a body is made to undergo a change from rest to motion, by the energy of any moving power; it is necessary that the power should be active and that the thing moved should be passive; and to produce motion perpetual, (i. e. perseverance in a state of motion), that the power must not only be active, but active infinitely; and the matter moved, not passive only, but passive infinitely; it is nevertheless asserted and laid down as the first fundamental law of nature, "*that every body perseveres in its state of rest or of uniform motion in a right line, unless it is compelled to change that state, by forces impressed thereon.*"

14. Although it is demonstrable also, that

if any moving agent is finite, the motion on another body which that agent produces, must be finite also; and that the same force, impressed upon the same body, under *unequal* degrees of external resistance, will not excite on it the same degrees of motion; but that the resistance which exists, no less in the body itself which is moved, than in the medium through which it passes; not only tends to change the direction of the motion which the force had impressed, but to destroy motion altogether;—the second Newtonian law nevertheless asserts or demands, "*That the alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.*"

15. Although the cause of motion is separate and distinct from the thing moved; that the one is the agent—the other the patient; and that the resistance of the thing to be moved, and of the medium also, have an unceasing and everlasting tendency, not only to obstruct and to weaken, but finally to destroy, the motion ex-

cited, as well as the force of the moving power; —it is nevertheless laid down as the third law of the Newtonian system, "*That to every action, there is always opposed an equal re-action; or the mutual action of two bodies upon each other, are always equal and directed to contrary parts.*"

16. Although a clear and obvious distinction exists between active and passive natures; between things that have the power of moving, and those that *are* moved;—between those that act and those that resist;—between the power of a horse and the passive resistance of a cart;—between the pressure of the finger upon a stone, and the resistance of the stone upon the finger;—between the re-action of a spring;—the expansibility of air and of fire; and the resistance in the bodies, which these agents are able to overcome, and which they project to great distances; it is nevertheless affirmed by this pretended law,—that a cart draws a horse as much as a horse a cart,—that a stone presses the finger as much as the finger presses the stone; thereby ascribing equal powers

to unequal causes, as if there subsisted a mutuality of power between them.[1]

17. Although it is mathematically demonstrated, that every part of the earth's surface is Spheroidal; it is nevertheless demanded, in order to make calculation square with the fact, that a portion of it should be considered a perfect plane.

18. Although all matter is acknowledged to be rough, all machines imperfect, all chords inflected; it is nevertheless necessary, in order to make mathematical rules explain natural phenomena, to suppose all bodies to be quite smooth, all lines to be perfectly straight, all machines to be without friction, all space to be without matter, and all matter to be without resistance.

Whoever consults the works of that great man, Lord Bacon, will at once perceive, that he followed a different course: he considered that

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[1] Vide ch. xiv. p. 271.

the elements of knowledge, ought ever to be definite and precise; that they should accord to the nature of things as they actually exist, not contrary to it. This declaration constitutes the very first aphorism proclaimed in the novum organum; his Lordship proclaims man to be nothing more, than the agent and interpreter of the phenomena of nature; that the observations which he makes of the order of nature, either practically by his senses; or by the aid of experiment; or in the abstract researches of his intellect; constitutes all that he can know and understand; nor does he, or can he know more.[1]

It was by a total departure from this golden rule that Sir I. Newton has nevertheless succeeded, in establishing his system of physical error; instead of bending and adapting mathematical rules to the system of nature; the system of

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"[1] Homo Naturæ Minister et Interpres—tantum facit et intelligit, quantum de Naturæ Ordine, re vel Mente observaverit: nec amplius scit aut potest."

nature has rather been made to bend and to be adapted to mathematical rules; insomuch that the science of mathematics, instead of being the mere hand-maid, has been elevated to the rank of mistress, in the science of physics—the phenomena of nature explained, in a manner and in a mode, different from those which they are found spontaneously to display; and the artificial rules which have been invented, for the purpose of explaining natural phenomena, have been supposed adequate to account for the causes, by whose energy those phenomena are produced. Who can read the Principles of Euclid and of Newton, without being forcibly struck with this observation? The postulates of Euclid are so reasonable in themselves, that whilst they demand, they immediately obtain our assent; the postulates of Newton, on the contrary, are such, as every reasonable man must reject. Whilst the definitions of the one, most accurately describe the attributes of the things defined, as they actually exist; the definitions of the other, for the most part, define things, not as they naturally exist, but as they are not; whilst the axioms of the

former consist of self-evident truths, to which every man of common sense must immediately accede; the axioms, or laws, as they are called, of the latter, instead of being self-evident truths, are mere assertions contrary to truth or to nature:—instead of being laws, which matter, in general, must obey; matter, for the most part, in the phenomena which it describes, falsifies the conditions of those laws.

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[1] As the different subjects which are detailed in this Essay, and others connected with them, are amply detailed in my last work, "*On the Principles of Physiological and Physical Science*," I here subjoin a Table of Contents of that Volume.

CONTENTS.

ORATION.

If the different means were traced, by whose aid different people have emerged from a state of barbarism, and of ignorance, and acquired civilization and knowledge, none would be found to have contributed so largely to the attainment of such ends, as those which have subserved the purposes of education and of instruction. To establish public or free-schools, for the education of the public, has been the first measure adopted by the wisest rulers and legislators of every nation. These schools form monuments the most splendid, to illustrate the benevolence of a Sovereign, and hand down to posterity the wisdom of his laws. The history of our own country furnishes us with a multitude of these bright examples, from the time of Alfred the Great, to the present period.

In early times, we may presume, the means were commensurate to the end—and that the chartered schools, which were established and dispersed in various parts of the country, were adequate to instruct the scanty population of the land. To the motives of benevolence, which formed, was superadded the wisdom of perpetuating, these establishments, not only by a code of laws and of regulations, but by a sufficient revenue, with which they were endowed. When we behold, at this time, the florishing condition of the great majority of these schools, and reflect on the extensive benefit, which society must derive from the instruction which they continue to impart to a multitude of individuals, in the elementary branches of knowledge, every heart ought to be impressed with feelings of gratitude and satisfaction.

I need scarcely bring to your recollection the schools of the Universities, those of the Charter-House, and of St. Paul's; of Winchester, and of Westminster; of Eton, of Harrow, and of Rugby; exclusive of others of inferior celebrity, formed and established by the nation, for the instruction of her children, or by the munificence of individuals, for the benefit of the whole.

I should not do justice to the age, or to the country in which we live, if I omitted to notice the extensive advantages, which the lower orders

of society, in general, are deriving, from the adoption of the easy and familiar mode of education, lately introduced into this country.

Without wishing to make any invidious distinction between the respective merit of different individuals, all impartial men, I am persuaded, will admit, that the public gratitude and support are due to those, who confer a great public benefit—to Dr. Bell, who first conceived the system, —and to Mr. Joseph Lancaster, for having, in an improved manner, so widely extended it.

The love of knowledge is natural to the human mind: the elements, once set in motion, are soon fanned into a flame, which not only illuminates the individual in whom it resides, but has an incessant tendency to improve all within its influence.

It is impossible, at present, to anticipate the influence, which the adoption of this system may ultimately produce in educating, or evoking, as it ought more properly to be called, the streams of knowledge, from their fountain in the soul. In its operation, it may be as extensive on the moral, as the lever of Archimedes would have been powerful, on the physical world.

It was in an especial manner, for the purpose of perfecting what the elementary schools had begun,

that Universities were founded; in which the accumulated wisdom of the wise, of all ages, might be collected by a few individuals, living in the same age, and residing in the same place; the universality of whose knowledge has dignified, with the title of UNIVERSITY, the seat of their abode. The learning, which these learned men had acquired, and the wisdom which they possessed, they professed to teach, and on those accounts, were called PROFESSORS.

In Scotland, these Universities continue to answer the ends for which they were designed—the means of diffusing general and universal knowledge, not to the noble and the wealthy only, but to the commoner and to the poor also; the practical benefits of which are felt and seen, far and near, on the moral and religious character of the people in general; and it will be acknowledged, that the Universities of Edinburgh, and of Glasgow in particular, continue to hold a distinguished rank in the schools of philosophy and of science.

If the present state of the English Universities be examined, if it be compared to what it was at more remote periods of our history, there will be found abundant cause for regret and for complaint. The University of Oxford, which alone (as it is affirmed) contained within its walls, at one time, 30,000 scholars, can now scarcely boast of having 800. The necessary, or at least the unavoid-

able expense, to which each student is exposed, renders, indeed, a University education, as it is called, confined within the grasp of the few, and beyond the reach of the many.

Convinced, as I am, of the necessity which subsists for every nation to have a National and established religion belonging to it; and of the high importance there is for the existence of situations, in which Students in Divinity may be properly and early instructed in the knowledge of the truth, I am disposed to lament, rather than to complain, that the objects of knowledge are not more extended; and that the various branches, which contribute to form the philosopher and the historian; the senator and the statesman; if not entirely discarded, are neglected, and discouraged.

The contracted system of education, prevalent in our Universities, is especially manifested with respect to the objects which relate to anatomy and physiology; to pathology and medicine. Although the Royal College of Physicians is abundantly supplied, from both Universities, with Graduates and with Fellows, with Censors and with Professors, it is to be deplored, that neither the public in general, nor the medical profession in particular, can be said to derive any essential benefit from the exclusive privileges they enjoy; a few annual orations alone, upon trite, and complimentary subjects,

being the only lectures delivered by the Professors of the College. The English Universities, therefore, are not so in reality, but in name only, and seldom complete what the schools had begun. Instead of being the permanent abodes of the studious, in which habits of application are to be acquired and naturalised, the moral virtues formed and established—by the rules of the University, the Students are obliged, during the periods of the different vacations, to quit, not only the several colleges to which they belong, but the precincts of the University itself. It will, I am persuaded, appear to be a mere mockery of education, not only to separate the links, by which a regular chain of study is connected, but to limit the terms of attendance to little more than six months of the whole year.

These are evils which inevitably flow, whenever *ends* are made subservient to *means;* the improvement of the Student, rendered subordinate to the convenience or indolence of the teacher.

With respect to the Corporation of Surgeons, the decrepitude in which it was sunk, is known to us all. Whilst it preserved the semblance of a body corporate, it had virtually lost the reality of its existence. It was a body without a soul. It possessed, it is true, a theatre, but it was a theatre without lectures: it had a library—but it was a library

without books: it contained a committee room, which had been converted into a dining parlour.

The neglect of employing the means which it possessed to answer the ends for which it was formed, led to the decomposition of the whole into its constituent parts, leaving the members alone without a corporation.

I sincerely hope that the college which has been formed out of these ruins, will be as superior to the Corporation of Surgeons in excellence, as it is more dignified in name.

I hope lectures will be regularly given to the members of the college, on anatomy, on physiology, and surgery. There are many of its members who must necessarily feel the want, without having the opportunity, of refreshing their memory by anatomical demonstration; of having detailed to them the various facts which physiologists have discovered —and of becoming acquainted and instructed in the different improvements which surgery itself has undergone.

When I reflect on the selection which the College has made of Professors—of Sir William Blizard and Sir Everard Home, the greatest hopes of benefit may be entertained. Of Sir Everard Home, the brother and the pupil of the illustrious I. Hun-

ter, and who has proved by the number of physiological facts which he has furnished, that he is worthy of so eminent a master;[1] of Sir William Blizard, the zealous and indefatigable promoter of every measure which can contribute to the honor of the profession, or confer benefit on mankind.

The defective state in the administration of most of these noble establishments, cannot be too deeply deplored. It has occasioned the system of education to undergo a total change. It has been the means of transferring education from public to private

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[1] Since the above was written, the lectures of the College of Surgeons have commenced; and I am particularly glad to find that Sir William Blizard is to give a course of lectures on anatomy and surgery: his long experience, and the ardor with which he has pursued the subjects on which he is to lecture, qualify him eminently for the task.

The lectures on comparative anatomy, which are now in progress of delivery by Sir Everard Home, are of the highest importance also, not only as they tend to enlarge the bounds of physiological science, but to make us more intimately acquainted with the functions of the human frame. The total and unequivocal recantation of the opinion which the professor entertained of the function of the spleen, does great credit to his candor and to his industry. Although his opinion was supposed to be proved by the test of experiments, I felt persuaded it was an untenable one, and that it would be abandoned in the way which we have seen.

schools—from the college to the private academy —from public orators and professors, to private teachers and masters.

How limited must be the means—how unprofitable, to the cause of science, must be the end, when emolument is made the paramount object of private instruction! I do not mean to decry the utility of private establishments in general, for the instruction of the young and of the ignorant: it is the ascendancy which they have obtained over public institutions, for the instruction of the public, which I reprobate and condemn.

If public establishments existed not in name only, but in deed—in which none were selected or elected to be professors and teachers, but such as were eminently distinguished by strength of intellect, and endowed with fertility of genius,—whose genius was matured and enriched by acquirements in the intellectual system,—in that vast ocean which comprehends, in its bosom, the principles and the causes of things,—as well as in different branches which relate to science and to art, the consequences would be direct;—men of leisure and of elevated minds, would be the constant attendants on these abodes. Pupils such as these, already initiated in the higher branches of science, would emulate the wisdom of their masters: capable not only to detect error, they would add to the stores of philosophy,

and lend their aid to the establishment of truth: we should not, under such a system, have to behold, as we now do, error constantly pass off for truth—truth for error; unrefuted, because undetected.

The effect which a plan of public education such as this, would produce on the mind of the teacher, would be equally striking and beneficial. In order to preserve the superiority which he ought ever to maintain over his learned pupils, instead of relaxing in industry, his industry would have constant motives for excitement; we might then look forward with the hope of possessing standards, (if I may be allowed the expression) to whom we might appeal, in the various branches of philosophy: that, increasing in wisdom as in years, we might at length approximate to the highest point of perfection attainable by man.

It is with that hope that I hail the formation of different public institutions, similar to our own, in different parts of this country: they are the images of which the universities are the prototypes; the benefits of which are as great, as they are extensive.[1]

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[1] In speaking of the Universities, I beg to be understood that I allude to what they *were*, more than to what they *are* at

The Royal Society, which was originally only a meeting of a few literary individuals at Oxford, rose gradually to the splendid zenith, which at the same period could boast of having a Halley for their Secretary, and Newton for their President. As a centre of communication, it is admirably adapted, through the medium of the Philosophical Transactions which are regularly published, to record the various discoveries which have been made, in different parts of the world. The extensive knowledge of natural philosophy which Sir Joseph Banks, the present illustrious President, has acquired; the zeal which he has exerted in encouraging every pursuit, which could add either to the elegancees or the comforts of society; have contributed in an eminent degree to raise it to the rank which it holds and preserves amongst the nations. It is to be lamented that it was deprived of the services of one of the most gigantic minds that ever lived, at a time he was Secretary: I mean Dr. Horsley, the late Bishop of St. Asaph: he retired from the society under the impression which he felt, that in encou-

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this time; the system of public examination which has lately been adopted at Oxford, by which academical honors can alone be acquired by means of academical merit, publicly displayed, is of itself an engine of such power, that it must necessarily set in motion every faculty of the mind, of ambition as well as of shame.

raging natural philosophy, it discouraged the higher branches of science. He therefore quitted the temple, as he expressed it; he quitted the temple where philosophy once reigned, and where Newton presided as her officiating minister.[1]

The Royal Institution, which was formed after the plan of the *National Institute* of Paris, under the immediate protection of our beloved Sovereign, soon acquired, by the zealous exertions of the different lecturers, and especially of the late Dr. Garnett, a considerable share of celebrity. Although science has to deplore his death, he nevertheless continues to live in the affectionate remembrance of his friends, in the esteem and regret of all who had the benefit of his acquaintance.

The distinguished and elevated situation which Dr. Garnett filled, has been most successfully supplied by Professor Davy. The industry and acuteness in chemical pursuits, which at an early age he displayed, were soon manifested by the detection of chemical errors, the extension of chemical

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[1] Whoever knew Dr. Horsley, must admit, that being conscious of the strength of his mind, he was seldom disposed to yield to the opinions of others; that he, in consequence, often appeared dictatorial and intractable; that although he had the fortiter in re, he seldom had the suaviter in modo.

knowledge; and have been rewarded by an unexampled portion of patronage and fame.

The advantages which the Royal Institution imparted to the inhabitants of the west-end of the metropolis, excited a laudable desire in a multitude of citizens, as well as of others in the counties of Middlesex and of Surry, that similar benefits should be extended to their respective districts; and, within a very short period, we have seen the formation of the London, of the Surry,[1] and of the Russell, Institutions. Whilst the two latter have at once attained a state of maturity and of activity, and in a most eminent degree answer the purposes for which they were designed, the former, on the contrary, is in a state of caducity, without having arrived at the period of adolescence: no lectures have been delivered, nor lecturers appointed, nor has the foundation-stone been laid for a building in which the meetings of the Society might permanently be held. Inde-

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[1] It is impossible to speak of the Surry Institution without expressing at the same time the obligation which it owes to Dr. Adam Clarke, the honorary Librarian: the learning which he has acquired, and the bibliographical knowledge which he possesses, is equalled by few, and surpassed by none. This knowledge he has displayed to the greatest advantage, in forming an extensive and most useful library for reference and circulation, composed of the best editions of the best books, both foreign and domestic.

pendently of a gaudy and costly collection of philosophical instruments, which have never been used; it can only boast the possession of a splendid library, which is seldom read, formed at a vast expense, out of the abundance of its means, by the critical knowledge and profound erudition of one individual, the late learned librarian Professor Porson.

Whilst it is a fact, that the immense sum of £80,000 has been collected upwards of seven years, none of the paramount objects of the Institution have yet commenced; experience has established the melancholy truth, that the pursuits of commerce are often at variance with the pursuits of science, and that the depository of wealth is not always the focus of philosophy. We ought not on those accounts to withdraw our support from this Institution: the evil is to be traced not to the Institution itself, but to the administration of it. Instead of obtaining great ends, with small means, it has unfortunately possessed great means without attaining, or apparently without even the power of proposing to itself, any beneficial end.

If the Medical Society of London, the anniversary of whose foundation we this day commemorate, in common with a variety of others that might be mentioned, (which are attached to public hospitals,) are inferior in internal wealth or external splendor

to those which I have named, it will, I trust, be admitted, that they equal them in public utility. Many of them can boast of possessing, in their lists of members, individuals of the most splendid talents, to whose labors the world is considerably indebted for a mass of useful information. The several volumes of Transactions, which have been published by our Society, are lasting records of its importance. I cannot close this part of my address without expressing the particular obligation which we owe to its original Founder, and whom I am happy to find this day elected President for the ensuing year: I mean Dr. Lettsom. The punctuality with which he attends the meetings of the Society, the active part which he takes in its scientific and medical conversations, with the length of his experience and the extent of his correspondence abroad and at home, as well as the liberal munificence towards it, which he has ever displayed, have contributed in an eminent degree to its support.

By the zealous exertions, in the cause of science, of our worthy secretary Mr. Pettigrew, a new Society has been formed, entitled *the Philosophical Society of London*, and which, I am informed, meets with great encouragement—If it attain the purposes which are detailed in the prospectus, it will contribute its share to the benefit of science, "by destroying, as much as is possible, that

false definition of words, which has been justly reprobated by Locke and Bacon, as the origin of sophistry and misconception; but above all, if it remove that barrier, erected by pedantry, against universal knowledge, which has established un esprit de Corps into Philosophy, and rendered it the territory of a sect of men rather than the province of the world!!"

Whosoever has paid particular attention to the pursuits and objects of science, will know how to cherish and to appreciate these establishments; in which opportunities constantly present themselves, not only to receive, but to communicate knowledge—to establish truth on its throne, and to tear away from error that veil, which too often prevents its exposure.

It would take not part of a discourse, but a long series of lectures, were I to expose the palpable errors which prevail in the different departments of philosophy.

The classification of the whole material world, which has been long made, and which at this time is generally adopted into *animal*, *vegetable*, and *mineral*, is highly objectionable, because extremely defective, instead of generalising, it particularises only; instead of comprehending the whole, it excludes a part;—it excludes that immense and in-

definite portion of matter which subsists out of the bowels of the earth, instead of being mined and immured within them. This classification not only excludes water and gaseous bodies in general, but the whole of the radiant and ætherial matter, which flows from different parts of the solar system in particular.

This error appears to have arisen from a desire of separating *living* matter into two kinds,—into animal and vegetable, and of confounding, by merging all *common* matter into one.

That such an opinion should have been entertained, must appear strange to men of common sense and common observation; it was so asserted by some philosophers of old, and in latter days has been sanctioned by the approbation of the illustrious Newton.

Whoever explores the qualities and properties, which different bodies possess, through the medium of the phenomena;—whoever examines or describes those phenomena, according to the mode and the manner in which they are spontaneously displayed, as every natural philosopher ought to do, will be led to conclude, that whilst there subsists a regular chain of order and of subordination, throughout the whole system of nature, and that the analogy between the different links is so close,

and the gradation so easy, that it is often very difficult to say where the one ends and the other begins,—what are the particular marks, by which some parts of the animal kingdom are distinguished from the vegetable,—some parts of the vegetable from the inanimate and common—will admit that there, nevertheless, subsist shades of difference throughout the whole, insomuch that when the extremes are compared, instead of analogy, there is a total difference between them.

Grounded on these obvious distinctions, is founded the new classification of matter, which I have made, and which I now offer to your consideration; viz. Into *living matter*, *dead matter*, *common matter*.

First:—By *living matter*, I comprehend the various orders of living beings, with which the universe is replenished and adorned.

Secondly:—By *dead matter*, I confine myself to the exuviæ of animals and of vegetables, as well as to the whole substance, of which these beings are composed, after the actions of life are at an end, and the state present which is known by the appellation of death.

Thirdly:—By *common matter*, I mean the primitive or original materials, or elements of which the

universe is composed;—matter, which either has never received the participation of life, or having received, has lost it, and been resolved back into a common state.

Correspondent to the difference of character, which different species of matter obviously possess, a subdivision has been made into such as is *solid*, *liquid*, and *gaseous*, exclusive of that immense quantity of radiant or ætherial particles, which flow from different parts of the solar system, and which follow the operation of laws, altogether different from those by which the matter of our own system is governed.

The necessity of these several divisions will be obvious, when I come to describe the difference which exists in the phenomena, which these different bodies severally display, they are great and striking,—they are as obviously different as those which subsist in the attributes of life and of death. It is to them that I shall now beg to direct your attention.

If we begin by examining the attributes of *common matter*, in its form the most simple and uncombined, it will be found that an increase of bulk alone ensues from the aggregation of the parts, and that if an union takes place between bodies whose qualities are different from each other, both

lose by the combination that ensues, some of the properties possessed separately by each, whether it be a solid or a fluid, an alcali or an acid, a metal or a gas.

If common matter is acted upon by some external agent, and motion is produced; the motion produced perpetually diminishes, and is ultimately lost, the matter impelled gradually recedes from the state of activity into which it had been excited, and it returns to the one in which it existed before, passive and inert. Whether, therefore, we contemplate the nature of *common* matter at rest or in motion, at unity or in union, whether the changes it undergoes proceed from motion mechanical, from mixture chemical, or from both together; we shall find it established as an universal truth, that the same effects uniformly result from the operation of the same causes. If on the contrary we extend our views to the various phenomena which *animated beings* in general display, we shall find that the faculties and powers, so varied and wonderful, which they severally possess, decidedly prove that each system, not only in the progress of its evolution, but in the actions it performs, is governed and impelled by laws distinct and peculiar, dependent on the class to which it belongs; and that the matter itself, of which it is composed, is in its attributes totally different from common matter in a passive state.

The change which the food undergoes, which supplies the wants, and which restores the waste that every living system undergoes, is one of the most striking proofs of this observation.

By the activity of the agent employed in this function, solids are liquified, liquids are gelatinised, inanimate things are animated, animated things are killed and revived, sapid bodies are rendered insipid, the most putrid matter is deprived of its putridity, and rendered antiseptic and fresh, the most fresh and antiseptic is made susceptible of undergoing the processes of putrefaction or fermentation.

The commutation which the food has undergone after the process of digestion has been accomplished, is total and complete, insomuch that all the physical properties which those substances before possessed, become either suspended or lost; gasses are bereaved of their expansibility, acids of their acidity, alcalies of their acrimony, all of the orders of their respective affinities and rendered bland and mild.

Whilst the phenomena which common matter displays, are regular and definite, and uniformly and invariably the same; we behold, on the contrary, the same kind of matter when applied to different living systems, as well as to the same

system at different times, changed into a nature totally different. We behold in the same field, and in the same soil, a multitude of vegetables fed and nourished by water and by air, in quality precisely alike, and yet assuming an organisation and form totally different: meat cut out of the same joint, bread from the same loaf, water drawn from the same fountain, and portions of air separated from the same volume, given to a man or a monkey, to a dog or a cat, will lose every vestige of its former qualities, and be converted to the particular nature of the system to which it had been applied.

Great and striking as appear to me the marks of difference by which systems, *living* and *common*, are characterised, all comparison is lost, when we reflect on the irritability and mobility, both voluntary, involuntary and mixed of the one, or the imbecility and passivity of the other—on the power of abstraction and of ratiocination of some, of restoration and reproduction of all. If I were to pursue the subject, language itself would prove too weak and insufficient to describe the difference which exists in the laws, by which animated beings are governed, and in those to which matter, either *dead* or *common*, is amenable.

This difference is manifested in a manner still more striking, when we contrast the uniformity of

effect which ensues from chemical combination, with the variety which results in the food, from the assimilating power of the digestive organs, insomuch that we are necessarily led to conclude that the effect produced does not proceed from the agency of a chemical cause.

If it arose from the agency of a chemical cause, the change which the food sustained, by the mutual and chemical action between its parts, would be regular and uniform. Instead of the result being always the same, it would be generally different in its nature. It would constantly vary in its properties, according to the specific quality of the substance out of which it was made. Instead of the remission and variation, which we often witness during the process of digestion, the process of digestion would be constant and definite.

It is therefore legitimate to conclude that the process of digestion, by means of which, different kinds of food are assimilated to one and the same species, is not a chemical, but a living act, and that the efficient cause of this commutation does not arise from any active or chemical property, which in the food inheres, but that it proceeds from the power of the organs alone, in which it is received, and by whose energy, the new arrangements of the parts are formed. It is this unifying power, which the assimilating organs

possess over materials discordant and heterogeneous, by which the act of digestion especially differs from aggregation simply, or from the more complicated phenomena arising from chemical union and combination. This assimilating power pervades the whole range of animated existence. It is in essence, the same in animals, as it is in vegetables; however diversified the construction of the organs may be by which the effect is produced. Throughout the whole, the organs are designed to reduce different substances to one kind, in order that this one substance, after it has been converted into blood, may be in harmony with the system at large, and fitted to be acted upon by the specific power of the different organs into various forms.

When the assimilating organs, therefore, perform their functions, with force and with efficacy, they possess the power of changing and of destroying the sensible and chemical qualities of the different articles of food they receive; they not only possess the power to act, but to resist action;—to change things, external to themselves, without being changed *by* external things;—*to convert them*, instead of *being converted by them*.

The matter, therefore, which every living system receives for its nourishment and support, can only arise out of its *aptitude* to be acted upon,

as its aptitude to be acted upon is derived out of its imbecility and weakness, out of its state of disorganization and deprivation, total and complete.

It is while matter subsists in this weak and destitute condition, with relation to the active powers resident in a living system, that I say it is a mere *tabula rasa* [1]—in all its parts a chaos—of power and of intelligence altogether void, as imbecile and inert as the shoe is without the moving power of the foot, or as the musical instrument without the art of the musician. It bears the same relation of *weakness* to the *power* of the organs, as the uncolored paper on which I write, does to the letters I am writing, or as the block does to the statue. If the block were already chiselled into a statue, the prior existence of that statue would render the marble, whilst in that figured condition, unfit for the art of the statuary, but being a plain surface alone, it becomes a fit recipient for the figures which the artist intends to engrave.

The nature of this relation, which exists be-

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[1] The attentive reader will here observe, that in using the same words *tabula rasa*, I apply them to a sense directly opposite to that to which Mr. Locke applied them. What he has affirmed of *mind*, I predicate, on the contrary, of *Matter*.

tween *capacity* and *power*, is illustrated by the properties which the air, which we breathe, bears to the organs of speech. If the air expired from the lungs, inherently possessed any particular sound, that particular sound would constantly manifest itself; but being destitute of all sound, it retains the capacity alone of being compressed and power of expanding: it thereby becomes fitted to be acted upon by the organs of speech, and through their instrumentality, it is modulated and harmonised, and language ultimately produced.

It is owing to the relation which exists in the aptitude of the soil, and the living power resident in the seed of plants, and in the fœcundated ova of animals; that the acorn becomes evolved into an oak,—the infant foliage expanded into leaves—and the whole process of nutrition and of growth carried on. It is this power which constitutes the architect and the fabricator, by whose energy the whole machine is erected;—it is the base on which the whole stands, it forms the bond of its elementary parts—the cement that unites those parts into one whole. This living power is the cause, primary and efficient, whence the individuality of every living system arises, in which the form and the sex it assumes essentially reside; by which the human species differs from the brute, the brute from the vegetable, the vegetable itself from matter inanimate or common.

It is this power which I call life. The matter which this living power has assimilated and organised, which I call *living matter.* It is this principle which has been named by Aristotle ειδος, by Stahl *vis medicatrix naturæ;* by Harris *form;* by Haller *vis vitæ;* by Blumenbach *nisus formativus;* by J. Brown *excitability,* (if the term has any meaning) and by the illustrious Hunter *principle of life,* a term which to me appears so appropriate and distinct, that I shall consequently retain it. The principle of life may be therefore defined "*the power by whose energy different species of matter are assimilated to one kind, a living system organised and formed, and the various parts of which it is composed, are protected and preserved from decomposition and decay.*"

The various organised systems, therefore, which we behold around us, are nothing more than *effects* produced; they constitute the obvious and manifest images, of which these principles or primary causes are the prototypes; it is through the organic phenomena which they severally display, that any knowledge can be obtained of the nature of their existence or of the power which they possess: —through the phenomena of life, we can obtain any knowledge of vitality; through sensation of sensibility, through consciousness of intellect, through the works of creation, that we can conceive a knowledge of the Creator: or as St. Paul elo-

quently describes it, "by which the *invisible* things of God from the creation of the world, are clearly seen, being *understood* by the things that are made; even his eternal power and Godhead,"—and as the universe in general is governed and directed by the infinite power of the Deity omnipotent; so it is the power of life which constitutes the first cause, and the first mover of every living system in particular, acting on matter, which it models into organisation and form.

In its essence, this living power must be as superior to the organisation, as the hand of the artist is more excellent than the pencil he employs; organisation is destined to display the phenomena of life, as the powers of life unfold and impart those of organisation.

It is therefore legitimate to conclude that life is not only a principle and a power, higher and prior to the organisation itself, and a fortiori to the phenomena that flow from it, but that the corporeal parts of vegetables and of animals, in common with those of man, are nothing more than instruments, subordinate and subservient to this principle; by the energy of whose formative power one whole system is constituted and formed. Instead of being formed by the same means as machines, inanimate and common, the whole formed and perfected by the addition of various

parts, by a power from without; we behold in every living system the various parts formed by a power from within—from one united and indivisible whole.

It is owing to the unity and totality of this principle or power, that the various parts of the same system are connected together by one and the same bond, that one part of the same system is not separated or divided from the other, but that it is all in all, one whole.

In its essence, it must be definite, because the body which it has formed, and in which it is contained, is limited in the extent of its growth, and is prevented from acquiring indefinite magnitude, although the causes for its perpetual increase continue to be applied.

It must possess a formative power, because every living system we behold, from the most gigantic and complicated, to the most insignificant and simple, is marked by a peculiarity in the order and arrangement of its parts.

In its energy, it must be active, not only because it imparts activity and form to the passivity and imbecility of matter, but becomes the primary cause of the various operations which this living matter performs.

In that energy, it must be temporal, because every living system is transient and perishable, and in a constant and unceasing state of progression, perfection, and decay.

Admitting these undeniable truths, the conclusion presses itself upon the mind with force irresistible,—that these attributes must of necessity belong to a principle immaterial, and incorporeal, by whose activity, matter formless becomes organised;—by whose vivacity, this organised matter becomes endowed with the power of action and motion, and constitutes the fountain whence health and disease are made to flow.

Before I proceed further, every inquiring mind will, I am persuaded, pause, and will ask this question: How comes it to pass, that amid the infinite multitude of animated beings which are created, we behold the individuals of the same species to be generally alike; whilst the several classes to which those species belong, are generally different from each other? Or in other words, what is the reason, that in the various links by which the whole chain of animated beings is connected together, that there should subsist such diversity in the organisation with which the individuals are endowed, as the instruments which they employ to perform their several functions?

How comes it to pass, that the vegetable system whose living power is more perfect and often more extensive than that of the brute, should hold the last rank in the series I have named; and on the contrary, that the human species, which is more complicated and consequently more indigent in its corporeal frame, than either brutes in general, or vegetables in particular, should hold the first rank and have dominion over the whole?

In exploring the ways of Providence, limited indeed is the short span within which human ability is confined: how imperfect then must be our knowledge on a subject so vast and extensive! Whilst we, perhaps, must for ever despair of acquiring a particular, it will not, I trust, be considered presumptuous in me to say, that we are furnished with the means of obtaining general information respecting it. This knowledge is to be derived by an intimate examination of the different instruments, which particular beings possess, by the power of which those instruments are invariably directed to perform certain determinate actions, in order that they may attain the end or final cause of the beings to which they belong.

When we examine the simplicity in the organic structure of the vegetable frame, and the regularity, with which its actions are performed, we are naturally led to conclude that those actions, constant

and definite as they seem to be, must flow from the operation of causes, uniformly and invariably the same; and that there does not exist any opposing or controlling power within the system, by the operation of which, those actions can be suspended or suppressed.

There is not only a progressive developement of particular organs, from the first period of germination to the full perfection of fructification, but an appointed season for the evolution of the living principle which the seed contains, the end of which seems to be *the propagation of the species, as the means, of affording nourishment and support to beings of a higher class.*

The means by which this effect is produced is not confined to one only, but often extends to several modes, and the offspring produced is perfect in all its parts; whether it has been evolved from a bulb, or from a bud, from a single leaf, or from a seed.

It does not, however, appear from any knowledge we possess of the vegetable anatomy, that vegetables have any organs either of sense or of consciousness, with which animals in general are endowed.

As we ascend in the scale of animated existence, we are enabled to distinguish, between different

classes of each, a considerable difference in the organisation, which they severally possess. Although all admit that this difference constitutes the source of classification in general; what is the peculiarity which gives the characteristic mark of an animal from a vegetable, still continues to be a matter of disputation. It was the opinion of Mr. Hunter, (whose labors have more contributed to the improvement of physiology than those of all others united,) that the existence of a stomach, or digestive apparatus, formed the distinguishing characteristic between animals and vegetables.

Whoever reflects on the immense forests that are elaborated by vegetables out of water and air only, will readily admit that the digestive or assimilating organs of these systems, are as extensive as they are perfect.

The true point of distinction, instead of residing in an organ, which is common to all, appears to me, to consist in the existence of a nervous system, peculiar to some, connected, for the most part, with a ganglion, spinal marrow, or brain. Although, in the zoophytes, and that large and intermediate class of beings, which connect the vegetable with the animal kingdom, there is a structure of a nervous appearance, which is expanded over the whole surface of the body, the

existence of a brain, as a distinct organ, is not to be discerned.

Whilst the existence of a nervous system, appears to me to form the true mark of distinction between vegetables and animals, so the magnitude of the brain, with relation to the organs of sense, forms the principal grounds of organic difference, between irrational and rational animals—between brutes and the human species.

The physiologists, who first directed their attention to this subject, proceeded upon false data:—instead of comparing the magnitude of the brain with relation to the size of the nerves, which proceed from it; they compared the size which the brain bore to the aggregate weight of the whole body. It is not, therefore, surprising, that from these data we should have had the most inconclusive reasonings. To Professor Sæmerring, considerable merit is unquestionably due, for having put the subject upon its true footing. He it was, who first pointed out, that the magnitude of the nerves, which proceeded from the brain, with relation to the size of the brain itself, was the true point, whence the comparison was to be made.

From this mode of investigation it was found,

that although the most rational systems, or higher orders of animals, have the largest brain, their organs of sense are comparatively small; and on the contrary, that the most irrational systems and lowest orders of animals, have the smallest brain, with organs of sense comparatively large.

It is owing to this comparative degree of power, in these organs of sense, with respect to that of the brain, that whilst the power of the organs of sense is strong, that of the brain is weak. So keen is the appetite in the organs of sense in brutes, that the highest gratification is felt in consequence of the impressions which they receive from external objects;—the desire of gratification in the organs of sense, is so strong, that no power in the brain, or seat in which consciousness resides, can controul or counteract it.

It is in this portion of the nervous system that the proximate cause of sensation resides :[1] the sensation of flavour, which the food excites, does not reside in the food, but in the organs by which it is selected, and on which the impression is made. Without the intervention of these organs of sense, it is impossible that animals could obtain any knowledge of external objects; without the eye, that they could obtain any knowledge of colour, without the ear, of sound, without the nose and

[1] Vide Ch. on Sensation.

tongue, of flavor and of taste. It is owing to this sensitive power, that we behold animals display fondness and aversion, appetite and inanition; by which they are enabled to distinguish without experience, in an intuitive manner, not only the fitness of the medium, in which, by nature, they are destined to reside, but the substances also, which are best fitted for the support and nourishment of their frame. To this sensitive power, is owing the fondness in a leach of blood, and its aversion to salt; that the duck and the chick in ovo, after having emerged from the shell, in which they are inclosed, take different directions; the one waddles into the water, the other hops into the barn; that the infant, as soon as it is expelled from its mother's womb, expresses, by the motion of its tongue and lips, its wants and its appetites,—that it selects milk and rejects vinegar. It is this sense of want and of appetite, which the organs of sense suffer, which constitutes the impulse whence all their actions spring, and to the relief and gratification of which, all their actions are especially directed; it is the principle whence the impulse arises, which may be called *instinct*, by the energy of which, certain organs are employed to perform certain determinate actions, *without* a view to any ends or consequences. It is a principle which exists in brutes in general, as well as in man when he acts like a brute, and is unquestionably more definite and powerful in the lower than in the higher order of

created beings. It impels them to act by sense without reason, by a natural and blind impulse, which they know not and cannot resist, by fatal necessity, by brutal appetite, the end of which seems to be *the gratification of the senses as the means, and the propagation of the species, as the end.*

With the human species it is far otherwise; the organic construction of his frame, decidedly proves that he has a different end to attain, than brutal appetite alone; although in animals, and especially in the lower orders, the organs of sense and the nerves which they inclose, are in general, of great absolute magnitude, and in most, if not all instances, of greater comparative magnitude, than they are in man; we nevertheless find the size of the brain in man, is *comparatively* larger than in any other animal whatever: the brain is larger in size in the white than in the black of the human species; it goes on decreasing, from bipeds to quadrupeds, from quadrupeds to birds, from birds to fish, from fish to insects, where all traces of the existence of a brain and nerves, as organs, separate and distinct, are altogether lost.

It is in beholding the vast variety which exists in the machinery which different beings possess, that we are enabled to see the difference in the end to which that machinery is to be employed.

If the end of human existence depended on the perfection and extent of living power, man would, in that case, not only be inferior to the brute, but the brute would be inferior in the scale of creation to the vegetable species.

If that end consisted in the extent or perfection of the organs of sense, there is not a cat or a dog, but might claim the superiority over him.

The same superiority over him might be claimed by the lowest orders of beings, if we were to estimate their attributes by the faculties of strength or of motion,—of restoration and reproduction.

Whilst the inferiority of man in all these attributes decidedly shows that a mere animal existence, is not his true destination; the greater degree of magnitude, as well as variety and complication in the fabric of the brain, (as the instrument, in which the principle of consciousness resides, independently of what his own reason proclaims), decidedly prove, that it is by the power and energy of his mind, by which he is principally signalised and characterised. Instead of the voluntary organs being subservient to the gratification of the appetite alone, and the mere panders of animal wants, they become the tractable instruments for reason to employ, ready to obey its call, but not to command it. It is under cir-

cumstances such as these, that we behold genius, from a state of captivity, spring forth and evolve into activity and vigor; the latent or dormant faculties of the soul, excited, and by education directed to those pursuits, which are alone attainable by man.

It is by this energy of reason alone, that man is able to employ the voluntary organs, with which he is endowed, as the instruments of his will, to relieve the afflictions, to obtain and to distribute the comforts, of human life.

It is by the exercise of the same power, that he is enabled to contemplate on the good, and to resist the bad; that whilst the mind is often excited by appetite and sense, it is nevertheless able to resist, to subdue, and even to act in direct opposition to them; often compelling the body to fast, when it craves for food, to take medicines, which convey to the tongue, impressions nauseous and painful; to expose the body to the inclemency of the seasons, and to various dangers; to make it submit to labor and fatigue, and patiently to suffer agony and death.

Dulce et decorum est pro patriâ mori.

It was this sentiment which prevailed in Cato's mind, that enabled him to despise the danger and

the disgrace to which he was exposed, by the tyranny of Cæsar; he felt that the soul, secure within itself, could smile at the drawn dagger and defy its point; that it could florish in immortal youth, unhurt amidst the war of elements, the wreck of matter, and the crash of worlds.

Admitting the truth of these observations, which must, indeed, have been apparent to every reflecting mind, the conclusion presses itself irresistibly upon the understanding, that the end for which man was created, is totally different from that of any other being.

Instead of being confined like vegetables to the production of the species, or like the brute, to the gratification of the senses; these objects constitute, in man, the lowest of the ends which he is designed to attain;—those ends which are most congenial to his nature, and which form the true end of his existence, more especially consist, *in the perfection of his mind, in order that he may be qualified to adore the Almighty, and become acceptable to him.*

While the attributes of vegetables, flow from the vegetable or living principle alone; those of brutes from the vegetative, the sensitive, and the irrational; man, in addition to these, pos-

sesses the *intellective* also, and may properly be defined, *a rational soul in an animal body, which it employs as its instrument.*

If these truths appear, as to well-ordered minds they must appear, plain and even palpable, it will be necessary for me to show, that in attacking opposite principles I am not fighting with shadows, or exposing errors that have been long exploded: they are not only in actual existence, but are in full vigor, and at this moment are spreading their pernicious influence; in proof of which I refer to a book on this particular subject; a book, which has been translated from the French into English by Dr. De Lys, and Mr. Kerison, — which has already gone through five editions,—the merits of which have been proclaimed in our Reviews,—which I understand, is strongly recommended by some of those, who may be considered the highest authorities in their profession, and is in general circulation amongst students, I mean RICHERAND'S ELEMENTS OF PHYSIOLOGY.

Instead of supposing that there exists a rational principle in man, whose tendency, when properly directed, is ever to obtain a paramount command over the organs of sense, Richerand on the contrary expressly declares, "that our *physical* (bodily) holds, "our *moral* nature, under a strict and necessary de- "pendence, (subordination) that our vices and our "virtues, sometimes produced, and often modified

" by social education, are frequently too, the result " of organisation :" " that so absolutely is sens- " ation the source of all our knowledge, that even the " measure of the understanding is according to the " number and perfection of the organs of sense, and " that, by successively depriving them of the intelligent " being, we should lower at each step his intellec- " tual nature, whilst the addition of a new sense " to those we now possess, might lead us to a mul- " titude of unknown sensations and ideas, and would " disclose to us in the beings we are concerned with, " a vast variety of new relations, and would greatly " enlarge the sphere of our intelligence."[1]

It is not my present intention to discuss the doctrine of innate ideas, on which Mr. Locke has so much dwelt: I shall only confine myself to show, that the principles which Richerand has assumed, are not less erroneous than they are degrading.

So far from the measure of the understanding being, as he states it to be, in proportion to the number and perfection of the organs of sense, I will, on the contrary, maintain, that the organs of sense are far more perfect in those animals that have the least understanding, than they are in those which are blessed with the greatest portion.

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[1] Page 355.

The organs of sense are far more perfect in brutes than they are in man; in savage than in intellectual life; in youth, than in old age. It is but justice to Richerand to say, that he is not the inventor, he is the mere propagator of this error. It emanates from that brutal system of philosophy, whose incessant object is, to elevate and to humanize the brute, whilst it degrades and brutalizes the man; or, in other words, which brutalizes man without humanizing the brute; which makes external sensation to be every thing, and internal consciousness to be nothing: whilst it encourages the improvement and the gratification of the senses; it neglects the cultivation of those more pure and noble pursuits which result from the energy of the soul. Whilst this system of false philosophy makes man a sensual, it prevents him from becoming an intellectual, being. Instead of directing the mind to internal consciousness and meditation, it leads his thoughts out of himself and directs his pursuits to the external world, of which he supposes himself the chief supreme. Instead of worshipping with humility, as a being dependent and accountable, the God of Nature, he contents himself with proudly and ignorantly exploring the external works of nature.

It were devoutly to be wished that these important truths could be the means of inducing some of

the teachers in our philosophical schools to alter their present plan. Instead of the multitude of zealous and intelligent youths, being taught the principles of materialism, which unfortunately too often grow with their growth, and strengthen with their strength; we might cherish the hope of seeing them learn and understand, at a period of their lives, when precepts have their greatest influence, the nature and end of their existence, the moral duties which they are to perform, the adoration which the creature owes to his Creator. If these precepts, which naturally flow from true principles, were duly impressed on the minds of pupils, every lecture of anatomy and of physiology, in the words of Galen, would prove a hymn of thanksgiving to the Almighty.

I have searched, but alas! I have searched in vain, in this large and thick-set volume, for some short passage which alluded to some of these important subjects; but I read of nothing else than of the affections of the soul, considered to be synonymous to the passions; the words are "*the Affections of the Soul, or the Passions.*" Nothing of those affections of the soul proclaimed, which flow from the love and fear of God, and from the influence of the Holy Spirit, on those who are pure of heart. None of those religious principles, detailed, which excite and produce the performance of our

moral duties with cheerfulness and contentment. None of those moral duties recommended, which bind by indissoluble ties, not only man to man, but the different members of which human society is composed. I, on the contrary, every where see, and deplore to see, the natural consequences which ensue from the principles assumed. Whilst I behold man made to resemble a beast, I have also to complain, that the woman, instead of being the comfort and the comforter, the pattern and the partner, of man, is supposed to be designed to answer the same purposes only, as those of a terrier bitch in a dog-kennel!!! If it appear improbable, that sentiments so detestable, should have been entertained by man born of woman, I shall, in justice to myself, quote the passage as it stands at page 367, vol. 2. of the original work, and page 467 of the translation. "The reproduction of the species is in woman the "most important object of her life; it is almost the "only destination to which nature has called her, "and the only duty which she has to fulfil in human "society. Wherever the earth is fruitful, and fur-"nishes man with abundant means of providing for "his wants, he dispenses with the services of woman "in obtaining from it the means of subsistence: he "releases her from the burthen of social obligations. "The Asiatic expects from the woman he maintains "in his seraglio, in a state of inactivity, nothing but

" pleasure, and children to perpetuate his race.
" Among some of the savage tribes of America, man,
" abusing the odious right of power, tyrannizes, it
" is true, over woman; reserving to himself all the
" advantages of social life, makes her bear all its
" weight; but this exception does not invalidate the
" general law, deduced from observation of all na-
" tions. Whatever withdraws woman from this pri-
" mitive destination; whatever diverts her from the
" end is to her injury, it is the scope of all her
" actions and habits; every thing in her physical
" organization has evident reference to it. Of all
" the passions in woman, love has the greatest sway;
" it has even been said to be her only passion. It
" is true, that all the others are modified by it, and
" receive from it a peculiar cast, which distinguishes
" them from those of man."

If any thing more detestable can be conceived, it is the brutality and profaneness which is contained in a note attached to this part of the text. In which the devotion and adoration, which women, as they are called, pay to the Almighty; and the love they feel to him, are represented to be of the same sensual amatorial nature, as the love which a common prostitute bears to the object of her lusts. Fontenelle used to say of the devotion of some women: " One
" may see that love has been here." It has been

said in speaking of St. Theresa, "to love God, is "still to love." Thomas maintains that with women "a man is more than a nation. Love is but an "episode in the life of man; it is the whole history "of the life of woman."[1]

In strict conformity with these odious principles, of making the measure of the understanding to depend on the number and perfection of the organs of sense, Richerand is led expressly to affirm, courage to be what it is not; instead of considering it to be one of the noblest faculties of the soul, he expressly affirms, "*Courage arises out of a con-* "*sciousness of strength,*" thereby confounding the bravo with the brave—the poltroon with the hero; the rational motives of a conscious being, with the instinctive ferocity of the brute.

Principles such as these may explain the physical causes of the dominion of the strong over the weak, of tyranny over oppression, of success, which when attained, is ever accompanied by shame and by disgrace, not of that true British courage, which in defeat itself, ever appears to be triumphant.

How differently was this noble attribute considered by an amiable author, "Courage," he ob-

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[1] Madame de Stael.

serves, "that grows *from constitution*, very often forsakes a man when he has occasion for it, and when it is only a kind of instinct in the soul, it breaks out on all occasions without judgment or discretion. That courage, which arises from a sense of our duty, and from a fear of offending HIM, that made us, acts always in a uniform manner, and according to the dictates of right reason."[1]

Was it, I would ask, a consciousness of physical or bodily strength, which impelled the multitude of heroes of which our proud country has to boast, to perform deeds of bravery and of glory? —that impelled the veteran Hawke, to be always searching for the enemy, always asking where are they? never how many are they?

Was it the feeble, the emaciated, the mutilated body of Nelson, that led his intrepid soul to court all dangers in that glorious career of honor and of fame, in which he so often bled, and at length nobly died?

Shall I speak of that old octogenarian, the venerable Kutusow,[2] who is pressed down with bodily

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[1] Vide Addison's Guardian.

[2] I understand this extraordinary man has lost an eye, has had a bullet pass through both his cheeks, has an irreducible hernia, and is nearly 80 years of age.

infirmity and weakness, not more the result of original imperfection in his physical constitution, than from the various lacerations which he has sustained in fighting the enemies of his country. A hero of the first order, by whose valor and skill, such deadly blows have been inflicted on the grand army of one of the greatest tyrants that ever desolated the world; the natural growth of a state of manners and of principles, such as those I have been exposing.

In tracing the existence of true courage, the result of the highest energies of our moral consciousness, I would more especially appeal to the lives and to the deaths of those holy men—those pious and venerable martyrs, who had the courage to oppose the despotism of Popery, and to expose its wicked influence: to begin the Reformation, and to die in its defence. Was it a consciousness of strength that gave courage to Cranmer, when surrounded by Papists and Jesuits, to thrust, with feelings of remorse, his feeble hand —his "unworthy hand" as he called it, into the devouring flame, in order that it might first expiate the crime he was conscious it had committed, in signing his recantation?[1] It was not a conscious-

[1] Although it is my earnest wish for every one to enjoy full liberty of conscience, and toleration to be allowed to the utmost extent, I nevertheless hope that if it be deemed right that the

ness of physical strength, which gave courage to those heroic martyrs, but that sublime and heavenly impulse, which enabled them to

"Chase each meaner purpose from the breast,
And through the mists of passion, and of sense;
And through the pelting storms of chance and pain,
To hold straight on, with constant heart and eye,
Still fix'd upon their everlasting palm,
The approving smile of heaven." [1]

Catholics should have any further privileges allowed, that the legislature will prevent them from obtaining any ascendancy in church or state. I shall quote a fact, which Richerand mentions to have happened under Louis the 14th, at the time he was persecuting the Protestants; and shall leave the reader to make on it his own comments: "The conversion of the "Reformed, in the Cevennes, was effected by bending them on "a bench, and tickling the soles of their feet, till, overpowered "by this torture, they abjured their creed: many died in the "convulsions and immoderate laughter which the tickling ex-"cited."

[1] If more were necessary to show the existence of mind, although influenced, yet acting independently of body, I would appeal to the 29th Bulletin, and convict a French philosophe by the pen of a French warrior. After detailing the calamities and sufferings, which the grand army had endured, Buonaparte observes: "Those men, whom nature had not sufficiently fortified to be above all the chances of fate and fortune, appeared shook—lost their gaiety, their good-humor, and dreamed only of misfortunes and catastrophes. Those, *whom she had created superior to every thing, preserved their gaiety, and their ordinary manners, and saw fresh glory in the different difficulties that were to be surmounted.*"

Richerand's ignorance of the nature of the rational and instinctive principles, which different animated beings possess, is not more marked, than of the nature of vitality itself;—of that power by which the living machine is formed, and through whose instrumentality the various ends are attained, which each is destined to fulfil. Instead of defining life, or vitality, as I conceive it ought to be defined; as the power, by whose energy different species of matter are assimilated to one kind, of a living system, organized and formed; and the various parts of which it is composed, are protected and preserved from decomposition and decay; our French philosopher defines life to be nothing else, "*than an aggregation of phenomena, which, in their union and succession, constitute life;*" that is to say, that the phenomena, or the effects of life, are the principles, or the causes of life, that consequently life is an end, not a beginning—a weakness, not a power—an ultimate effect, not a producing cause.

Hoping that every thinking and well-regulated mind will feel sickened and disgusted with the follies and abominations, which I have detailed; it would have been some relief, if the physiological explanation of the organic functions, could have enlivened the darkness of the picture, which I have described; but, alas! there

No light, but rather darkness visible
Serv'd only to discover sights of woe.

Woeful, indeed, is the sight of the horrible cruelties, which Richerand inflicted on different animals, with a degree of cold-blooded apathy, revolting to the best feelings of our nature. These experiments were made for the purpose of seeing the effects which the total retention of urine in the kidneys would have upon the constitution, in producing, what he calls, urinary fever; a disease, which he states to have seen in the human species. After having given a history of this excruciating complaint, "accompanied by a yellowish and oily moisture of the skin; a parching thirst, with which the patient was tormented; dryness and redness of the tongue and throat, &c." he then proceeds to relate the appearances, which he beheld in a cat, and in a rabbit, in which he excited the same disease by the most agonizing means.

Distressing as this narration may be, it may have its use; it may perhaps be the means of lessening the system of torture, which at this time is in full activity, by confining it to objects of real utility.

"I observed," he says, "similar appearances in a cat, and in a rabbit, on which I tied the ureters. Nothing is easier than to find the ureters, and to per-

form the experiment. After a crucial incision of the parietes of the abdomen, on the right side, the intestines are pushed aside to the left, so as to apply a ligature on the right ureter: they are then pushed to the right, while the left ureter is tied. When the ligatures have been applied to the ureters, about the middle, the divided edges of the abdomen are brought together, and united by sutures; and the body of the animal is wrapped round with a cloth soaked in some emollient decoction!!!" (how tender and merciful!) "At the end of thirty-six hours, the animals became exceedingly thirsty and restless, their eyes glistening; their saliva, which flowed copiously, exhaled a smell evidently urinous; on the third day the cat was seized with vomitings of a slimy substance, having the same smell; a convulsive agitation, followed by an excessive prostration of strength, when the animal died;" &c. I shall not stop to animadvert on this case. I shall merely observe, that there is not any symptom, which might not have been anticipated; but, instead of referring the symptoms to the absorbtion of the urine, they are rather to be ascribed to the inflammation of the kidneys excited by the ligatures on the ureters. It forms one of a multitude of false, or mock, facts, which are constantly advanced by physiologists, who take artificial and unnatural phenomena for the purpose of explaining the natural and healthy functions of the organs.

If I were to enter into a critical analysis of this work, there is not a page in it, which is not deserving the severest animadversion. The anatomical knowledge of its author, appears to me, on many occasions, as defective as his physiological explanations are erroneous. I shall quote an example, which happens to be casually under my eye at this moment. It relates to the absorbent vessels. I do not blame Richerand in particular for blending under one and the same head, the vessels, which absorb the chyle, with those, that absorb the decayed parts of the system; or, in other words, those, which convey to the blood a supply of nourishment from without, with those, which absorb the parts of the system which are worn out and diseased within. This error is common to our physiologists in general:[1] I charge him with the exclusive error of supposing that these vessels terminate in a way, which every lad, in every anatomical school, knows to be false; and that from this anatomical mistake, or ignorance, he is led into a physiological error: "The metastasis of humors "from one part of the body to another at a dis-"tance, is easily understood by any one, who has "seen the numerous inosculations of the lympha-"tics rendered manifest by injection. Metastasis "ceases to be an inexplicable phenomenon; one "has no difficulty in conceiving, how, by means

[1] Vide my System of Physiology, Vol. II. p. 416.

" of the lymphatics, all parts of the body commu-
" nicate freely; how, fluids, absorbed by those
" vessels in one part, may be conveyed into an-
" other, and pervade the whole body, *without fol-*
" *lowing the circuitous rout of the circulation;*
" and that it is therefore not altogether impossible,
" however improbable, that fluids taken into the
" stomach, may be conveyed directly from the sto-
" mach to the bladder, and that, in the same man-
" ner, the milk of the intestinal canal may find its
" way into the breasts; and that pus may be re-
" moved from the place in which it is collected,
" and be conveyed to the place, to which irrita-
" tion calls it forth!!!". For the present, here I must stop with Monsieur Richerand—with this galimatias—this hodge podge—this noted book, made up of scraps and of shreds—of odds and ends patched and stitched up together, without method or arrangement—without beginning, middle, or end; in so much that, taken as a whole, it is as unfit to instruct the student in physiology, as the subject of it is beyond the abilities of its author.

If I proceed from physiology to physics, to that science, which treats in an especial manner of the mechanical properties of common matter in general, and which endeavours to explain the phenomena, which those properties naturally display,

it will be found that we continue in the very infancy of our knowledge.

The essential attributes which different bodies possess, the first and most simple elements of which they are composed, and the definitions, by which those elements are characterised, continue to natural philosophers, points of constant controversy and disputation.

This ignorance appears to me, to arise from the manner in which the subject has been pursued. Instead of explaining the phenomena of nature according to the mode and the manner, in which nature herself describes them; instead of adapting the rules, or laws, to the phenomena; the phenomena have been adapted to the rules. Artificial phenomena, effected and produced by unnatural and factitious means, have been assumed for principles of physical science. A condition of things has been required, which in nature does not exist, but which must, nevertheless, be pre-supposed.

Whilst it is the amiable practice of weak and diffident characters, to reverence high authorities, and implicitly to submit to their opinions; it is, nevertheless, not more the paramount duty of all independent and inquiring minds, to expose those opinions when they are wrong, than to confirm them when they are just.

These errors are in a great measure to be ascribed to a man, who was avowedly one of the greatest mathematicians that ever lived, but whose attainments, in natural philosophy, bear no proportion to his eminence in those sciences, which may with equal facility be employed to demonstrate a system of error as truth. A man dear to every Englishman, because he made England illustrious, and whose fame is indelibly written in the records of the world,—shall I dare to pronounce the name of Sir Isaac Newton, clarum et venerabile nomen!!!

Instead of supposing that there subsists an essential and absolute difference in the quality of different species of matter; instead of adapting particular laws to each; he has, on the contrary, made one general law for the government of the whole.

By confining himself to the doctrine of universal gravitation, he has confounded, under the same law, bodies, whose properties are toto cœlo different from each other; he has not only confounded matter solid and fluid, opaque and rare, active and passive; but even extended this unnatural law to the government of the whole planetary system, and has been led to conclude that the motions of the heavenly bodies are governed by the same laws, as the rotten apples that

fell from the tree in his garden. Had that tree been immersed in water, and not in air, instead of the apples falling to the ground, they would have risen to the surface of the water; and it is probable we should not at this day have to complain of the universal conclusions which have been deduced from one solitary fact; much less, that an effect such as this, would have laid the foundation stone of this stupendous and ponderous system.

According to this system of physics, it is assumed, as a principle, that no bodies really light are to be found; that what is called *relative* levity, is not true levity, but *apparent* only—that as all bodies gravitate towards the earth, so does the earth gravitate again towards those bodies, insomuch that the attraction of gravitation is supposed to be mutual and equal on both sides. It was from a process of reasoning such as this, Sir Isaac Newton concluded, that the sun, from its relative magnitude to the other parts of the heavenly bodies, formed the attracting centre of the planetary system.

Instead, however, of supposing that the sun, as the source of light, actually and absolutely possesses an attracting power, the motion of the matter of light from the surface of the sun, shows that it is repulsive in the greatest degree that the ima-

gination can conceive. If the sun were an attracting body, if a power such as this existed in the sun; (the source whence the rays proceed) the solar rays, instead of issuing out of it, would be attracted by it and retained in it; they would be as fixed and immoveable in the body of the sun, as the primitive mountains to the solid nucleus of the earth; and the universe at large would be involved in absolute and utter darkness.

Notwithstanding these probable truths, the attracting power of the sun might have passed off, as an assumption without contradiction, from which an hypothesis might be formed; but when Sir Isaac Newton declared that the sun, this *attracting centre*, was a globe of fire; an inquiry into the nature and properties of fire, became the duty of every man who has the smallest power of reflection. I would ask any one, from the repulsive properties which fire is known to possess, what must be the effects produced by its influence on all bodies exposed to its power. Is it, I would ask, reasonable to suppose, that fire, which is known in all its essential properties to be the most *repulsive* body of which we have any knowledge, can be an *attracting one;* and does it not appear an absurdity, to make the very focus of repulsion, the very depository of attraction?

With so much certainty does Sir Isaac Newton

speak of this fact, that the sun is a globe of fire; that he has actually calculated the degree and intensity of fire which particular bodies must receive from its influence. The subdivision of votes, which lately took place at the election for Weymouth, in which the 1400th part of a 68th of a 5th of a two and sixpenny rate, was deemed sufficient to qualify a man to have a vote in that rotten borough, was as nothing, when compared to the indefinite division of fire which issued from the sun, by whose efficiency, the different parts of the solar system are supposed to be warmed. Sir Isaac calculated that the comet of 1680, during its perihelion from the sun, *must* have been 2000 times hotter than the heat of red hot iron, and would have taken 50,000 years to cool; a furnace such as this would have evaporated and dissipated every particle of matter belonging to it. Such assertions only serve to show how easy it is for truth to tell a lie, and false deductions to be made from mathematical principles.

The truth is Sir Isaac Newton was not more erroneous in his conclusion, than he was in this fact which he had assumed. I will venture to say, without fear of contradiction, that there is not a man of common sense, and of common observation, from the equator to the poles, who has ascended the highest mountains in the different regions of the world, but knows, that notwithstand-

ing the purity and rarity of the medium through which the solar rays are there transmitted, that the temperature is always lower at the top than at the bottom of a mountain; that the summit of the Alps and Appennines, of Olympus, and of Teneriffe, in common with those of the Andes, &c. which are situated immediately under the sun, are everlastingly covered with snow, and consequently that it is legitimate to conclude, as I have done in the last book which I have published, that the sun is not a globe of fire, but of pure light only.

The assumption of a false fact, for a principle, is always accompanied by an erroneous application of the phenomena that flow from it. In order to make every thing bend to this doctrine of universal gravitation, which it was presumed Sir Isaac Newton had established, by whose operation all substances whatever were supposed amenable to its influence, a string of philosophers, almost as long as the atmosphere is high, beginning with the Honorable Mr. Boyle, and ending with Dr. Hutton, with Professor Playfair, and Sir H. Davy; concluded that the different strata of the atmosphere, by which this world is surrounded, increase in density and weight from top to bottom, in a manner similar to a quantity of fine carded wool, piled up and thrown into a deep pit, the lower strata carrying the weight of the upper, by which they were compressed; that

the weight of the atmospheric column on the horizontal plane, is in proportion to 15 or 16lbs. to every square inch of surface, and as there are 144 square inches to every square foot, it must consequently sustain a pressure of weight equal to 2304. Supposing therefore that a man in an erect posture covers a surface commensurate to a square of eighteen inches, it must in that case follow, that the perpendicular pressure of weight of the atmosphere upon him, must be equal to five thousand, one hundred and eighty-four pounds.

But when a man is in a recumbent position, or when the surface of his body may be supposed to be increased to at least a square of eight feet, it is affirmed, and very justly affirmed, if the position were true, from which these conclusions are drawn, that such a one must sustain the enormous weight of near seven tons for his ordinary load.

From the operation of the weight of the atmospheric column, it has been supposed the Magdebourg hemispheres are kept in close contact, —that a thin glass bottle exhausted of air will burst,—that the exhausted receiver is fixed to the pump plate,—that a bladder with which a cylinder may have been covered will crack,—mercury forced up an exhausted tube to the elevation of twenty-eight or thirty inches, and water as high as thirty-four or thirty-six feet.

No conclusions more erroneous ever were made, they are the results of false principles, which suppose that the pressure which the atmosphere exerts, is the pressure of weight, and not owing to the pressure of expansibility which air essentially contains.

They may be said more especially to arise from the superficial view which dogmatical, but ignorant men have taken of the subject; who have always been led to suppose, that wherever there was pressure there must be weight, thereby confounding the variety of causes by which pressure may be produced, with the operation of one only—of weight, that is to say the pressure downwards of a dense body, when it is situated in a rare one, for such is the manner in which weight ought properly to be defined. [1]

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[1] As the nature of weight ought to be clearly understood, I refer the reader to those chapters in the volume I have published for a proper apprehension of it, in which I have shown, that weight is nothing more than the measure of the difference which exists between the density of one body with relation to the rarity of another; or in other words, between the proportion of matter contained within the same bulk; and as a vacuum does not exist, that is, space without matter, the doctrine of absolute weight must be for ever abandoned.

"Absolute weight," says Sir Isaac Newton, "is the whole "force, wherewith a body tends downwards; but the relative

Independently of the error of estimating the attributes of different bodies, by those that are secondary and accidental, instead of those that are primary and essential, it will upon inquiry be found, that there are a variety of bodies which possess the relative and accidental property of gravity and of levity, and which do not act by virtue of the one or of the other.

A muscle, for example, may be said to have weight in air, and levity in water; and yet it is not from its gravity or levity, that its power of pressing is derived.

" and vulgar, is that excess of gravity, whereby a body tends " downwards more than the fluid that surrounds it." " Gra- " vity," says Mr. Adams, " is that action, by which a body feels " heavy, when supported by one hand, and by which, when un- " supported, it falls to the ground." Wishing, however, to obtain the most approved definition of weight, as understood at this time, I succeeded in my object, and give the following one as coming from the highest authority. " Weight is the measure of the force of attraction, which obtains between bodies in mass." It is also to be observed, that weight *upwards* is supposed to exist; I shall give my own definition of weight, and leave the reader to judge for himself. Gravity, or weight, I define to be the pressure downwards of a dense body immersed in a rare one. The degree of pressure downwards, or in a line perpendicular to the horizontal plane, is the measure of the difference which exists in the quantity of matter, contained within a given bulk, with relation to the quantity of matter which is displaced, and the cause of weight—of gravity and of levity is the natural

A spring may be said to have weight, and yet it will not be pretended that it is to its weight that the pressure which it produces is to be referred. Whoever reflects on the forced and unnatural means which it is necessary to employ, in order to ascertain the rarity or the density, the levity or the gravity of air, will be led to conclude, that it is not by these attributes that its power ought ever to be meted or measured; for although the expansibility of air, is not only equal to, but infinitely greater than its weight; its weight is not equal to, but infinitely less than its expansible power. A pint of hydrogen gas that does not weigh half a grain, is able by its expansive force to tear asunder the firmest substance.

It is equally erroneous to confound expansibility with elasticity, and elasticity with flexibility, as well as capacity with power, as to confine pressure to weight alone.

So totally and absolutely inert is the solid matter of which this world is composed, that it pos-

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tendency all bodies possess to restore themselves to their proper level. However skilful our present philosophers may be in chemical analysis, many of them are ignorant in the analysis of logic; I will venture to say from my own experience, that if the reader were to inquire of the generality of them, what is meant by pressure, they would immediately connect with it the idea of weight alone.

sesses within itself no power whatever by which it can act. When any solid substance is acted upon by any moving power, the change which that substance undergoes altogether depends on the nature of its construction: if it cracks or breaks without yielding, it is said to be brittle, as flint; if it yields without breaking, it is said to be *flexible*, as lead; if it returns back to its original situation after the external force is removed, it is said to be *elastic*, as steel and whalebone, &c. The distinction, therefore, which exists between elasticity and flexibility consists in this, elasticity has the capacity to be bent by the power of an external force, and the power of restoring itself to its natural and original situation, from which it had been forcibly distorted and withheld; whilst flexibility on the contrary, has the capacity to be bent only, without any power of unbending itself.

Elasticity consequently consists of two properties, of weakness and of power, of passion and of action, of suffering to be, and of becoming to be, —of flexibility through the agency of an external force, and secondly of re-action from internal and inherent construction.

If I proceed from flexible and elastic bodies, to consider the attributes of those that are essentially *expansible;* they will be found to differ from both in points the most important. Instead of requir-

ing the pressure of an external force, in order that they may be enabled to unbend and expand; external pressure alone is the means by which this expansive power is bounded and confined—instead of being like flexible and elastic bodies, naturally passive and artificially inert, they are *naturally* active, and *artificially* passive, they are made elastic by external pressure, but are expansible without it. The instant external pressure is removed, this expansive power is immediately developed from its confinement, and displayed by its activity; spreading and dilating to the utmost extent which the imagination can conceive, communicating motion to the passivity of different bodies, and causing pressure on all.

It is this original and essential power, abiding in gaseous and aeriform bodies, that gives them the generic character of expansibility strictly so called, identifying their nature, and distinguishing them from every other class. Whilst the addition of an external force is absolutely necessary to make an elastic body become a flexible one; it is by the subtraction of an external force that gaseous bodies are enabled to expand. Elasticity, therefore, is merely *vi effecto*, a power which is derived, but which does not exist essentially or originally; it is an excited not an inherent power, whose energy immediately ceases the moment the compressing cause is removed, and the

particles of which the elastic substance is composed, have returned to their natural and former situation.

In matter, however, which is essentially expansible, it is far otherwise; instead of *vi effecto*, it is *causa motus;* not derived from without, but which subsists inherently within; not produced by external means, it is through the resistance alone, opposed by external means, that this expansive power can be either suspended or suppressed.

The difference may be easily proved by placing a flexible, an elastic, and an expansible body together, in the same relative situations; if a small portion of air inclosed in a large bladder, be placed under the receiver of an air pump, with a piece of steel and lead, the change which the air undergoes is totally different from that of the other two; in proportion as the air within the receiver external to these bodies is abstracted, it is found that neither the steel nor lead undergo any change whatever; the air on the contrary within the bladder dilates and expands to the utmost extent.

Mr. Boyle was of opinion that air was capable of expanding in the proportion of from one to one thousand times; and Sir Isaac Newton considered this expansible property to be almost unlimited; inas-

much that if a cubic foot of air, were removed to the elevation of one semi-diameter above the surface of the earth, it would expand and extend as far as the orb of the planet Saturn. When we reflect on the energy, which such a power is capable of exerting, we can be at no loss to conceive the resistance which it overcomes—to overcome the bond of union, by which bodies the most solid and compact are held together—to dislocate and divellate mountains of the greatest magnitude, into rocks:—to lacerate those rocks into fragments—to pulverise those fragments into sand the most subtle and impalpable.[1]

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[1]. In the various and multiplied discussions on this subject, which I have had with numbers of scientific men, I have not found one individual among the mass, who had any conception of expansibility, subsisting as an inherent and essential power —of expansibility, independent of external resistance. The utmost extent of their knowledge on this subject was limited to re-action alone: to that sort of power, which is derived, in consequence of external pressure. These prejudices are entirely the result of former errors, handed down to us, through the medium of the different commentators on the laws of nature, as they have been called by Sir Isaac Newton, from whom they originated. So far, however, from considering these laws to be laws of nature; from all the attention which I have given to them, I am bound to declare that they are mere assertions contrary to those rules, which nature herself observes—mere abstract terms, which require a condition of things, which in nature does not exist, but which nevertheless is to be presupposed.

Although various external circumstances, frequently tend to direct this expansive power into different channels, wherever air is situated in space free and unconfined, its expansibility acts equally in every direction: radiating, as it were, from a centre, it becomes extended to the whole circumference.

In order to show the expansive force of air in every direction, I shall have less necessity to add new facts to old principles, than to give new principles to old facts. This expansive power of air equally in every direction, is proved alike by the recoil and bursting of a canon, when the air in it is too closely compressed; as it is by the spherical appearance which every air bubble assumes. It is by virtue of this particular attribute, that every portion of air is in equilibrio with the whole; that it has as much the power of rising as of falling; that it possesses as much of levity, as of apparent gravity; as much the power of pressing bodies upwards as downwards; of ascending into the nostrils, as descending into the lungs; that a small portion of air, separated by the thinnest covering possible, from a larger column, suffers no additional pressure; that the back of my hand sustains no more pressure from the large column above, than the palm from the small portion of air below it; that we feel no weight; that we suffer no violence; that we are exposed to no danger;

that, in fact, the equable pressure of the air, in every direction, under the same circumstances of external influence; is no more capable of flattening our bodies to a cake, than it is of bursting the parietes, or sides, of the thinnest air bubble that can be conceived.

Hoping that the facts, which I have advanced, are sufficient and conclusive, to prove the expansive power of air, independently of external influence, to be equal in every direction; I shall now proceed to detail the effects which are produced by the air, when there exists an inequality of resistance in the medium by which it is surrounded.

Whenever the subtraction of external resistance takes place, from any one part; the expansive force of the air, becomes immediately dilated, and directed to the particular situation, where the least resistance exists; a change of pressure consequently ensues; from equality to inequality, from *radiation*, equally every where, to *projection*, unequally *somewhere*.

Is it not legitimate to conclude, that it is owing to the unresisting state of the upper regions, that the whole column of the atmosphere progressively decreases in density, in consequence of increased dilatation? That while the expansion of the upper

strata takes place, a progressive diminution of pressure from the top towards the bottom will be the inevitable consequence? similar to a small portion of air in a large bladder, under the exhausted receiver; insomuch that the pressure of the air, on the surface of the earth, will be less in degree sideways and downwards, than it will be perpendicularly upwards. So far, therefore, from assenting to the opinions, which have prevailed for the last century, that the strata of the atmosphere increase in weight from top to bottom, like a bag of wool, the lower strata carrying the weight of the upper; I contend that the actual condition of the atmosphere is the very reverse of this. So far from the lower strata subsisting in a state of condensation, like the lower strata of the wool, from superincumbent compression; the lower strata of the atmosphere are in a comparative state of expansion upwards, from a diminution of superincumbent pressure.

So far from the lower strata of the atmosphere supporting the upper,—the upper strata are rather pressed up by the expansive force of the lower. Instead of a gradual and progressive sinking and condensing of the whole mass, from top to bottom; there is, on the contrary, a general rising and lifting up of the whole mass from the bottom towards the top; insomuch that the rarefaction, which there exists, proceeds from decreased expansibility, in consequence of increased dilatation; and not from the

diminution of weight, from shortness in the length of the atmospheric column; and, on the contrary, that the progressive increase of pressure which the atmosphere exerts, from the top to the plain surface, arises from the increased expansibility of the air, from decreased dilatation, and not from an increase in the length of the atmospheric cylinder.

That this conclusion is a legitimate one, will appear, when we reflect on the sources from which the atmosphere is derived. I will not pretend to say, what might have been the condition of things at that memorable epoch, the moment of creation: at that memorable epoch, when the earth was without form—that is, when matter existed, without figure—when void, and when darkness were on the face of the deep—of that immense space between the waters below and the heavens above; in which no air or atmosphere existed to fill it; no light to illuminate it; no fire to warm it; and in which nothing subsisted but the omnipresence of the Almighty, who "moved with his spirit upon the face of the waters." When God said, "*Let there be light, and there was light!*" It was not said, let there be color, let there be fire; but it was said, *let there be light.* At that eventful period a new order of things arose, and effects the most violent, it is to be supposed immediately followed. Not only the whole of the planetary spheres were filled with that subtile matter, but with the dif-

ferent bodies, which it had acted upon; and changed from a solid and liquid to a gaseous and igneous state. Such is the essential attribute which belongs to these different bodies, of expanding and of diffusing themselves; that the plenitude of matter in space, is found to exist *every where, and a void no where;* that, as *extension* is the essential attribute of matter, so *space* is the necessary recipient of it; and, as matter cannot exist without space to contain it, so space cannot exist without matter to fill it. Instead, therefore, of supposing, as the Boylean theory seems to imply, grounded and founded as it is on the Newtonian doctrine of universal gravitation, that the atmosphere, by which this globe is enveloped, is dropped from the heavens above, to the surface below; I, on the contrary, maintain that it is generated and formed by the means I have detailed, at the surface below; and by the power of expanding, which air possesses, it becomes extended to an indefinite height.[1]

It has been owing to this fundamental error, of ascribing to weight (or the pressure downwards of a dense body, when immersed in a rare one) the pressure which the atmosphere exerts; that a great proportion of the false theories in natural philo-

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[1] Vide c. viii. p. 177. On the Means by which compound Bodies are formed; and c. ix. p. 187. On the Process of Gasification. Principles of Physiological and Physical Science.

sophy are to be referred. It is to the operation of this cause that the exhausted receiver of the air-pump is supposed to be immoveably fixed to the pump plate. The bladder, with which a cylinder may have been covered (after the air has been exhausted out of it) is made to burst,—quicksilver forced up an exhausted tube, to the elevation of twenty-eight and thirty inches, and water in pumps thirty-four and thirty-six feet high.

In order to prove that these effects are not caused by the gravity or weight of the atmosphere, but by its expansive force; I submitted them to the test of experiments, in themselves so simple, that I am happy to say, (with the exception of a few, very few, bigots, who I will venture to affirm, merely teach what they have been taught; and who have not the patience to trace effects spontaneously produced to their producing causes) they have proved as satisfactory and conclusive to all others, who have seen them, as they have done to me.

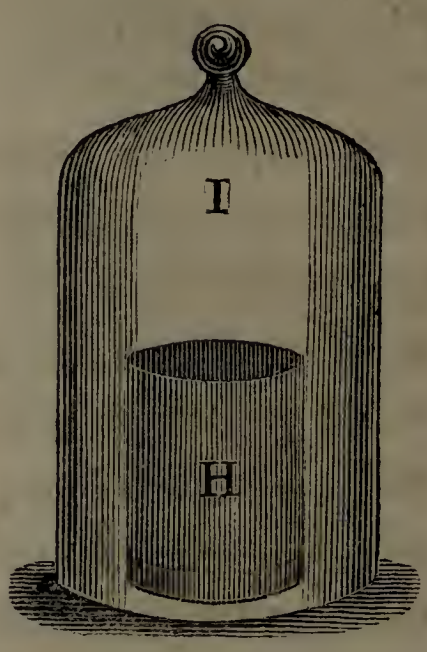
1st. That the rupture of the bladder, with which an exhausted receiver is covered, is not caused by weight or the perpendicular pressure downwards of gravitating or ponderable air; is proved by the bladder bursting with as much facility if it be exposed to the lateral, as to the perpendicular pressure, upwards as downwards.

In order to prove that the bladder on the exhausted receiver is not *burst* by the *weight* of the

atmosphere, I placed a small cylinder, having a bladder closely tied over its top upon an exhausting pump; and over the cylinder thus capped, a receiver; so that there were between the receiver and the cylinder, six cubic inches of atmospherical air, weighing about ten grains, from which the external air was entirely excluded.

H A small cylinder covered with a bladder.

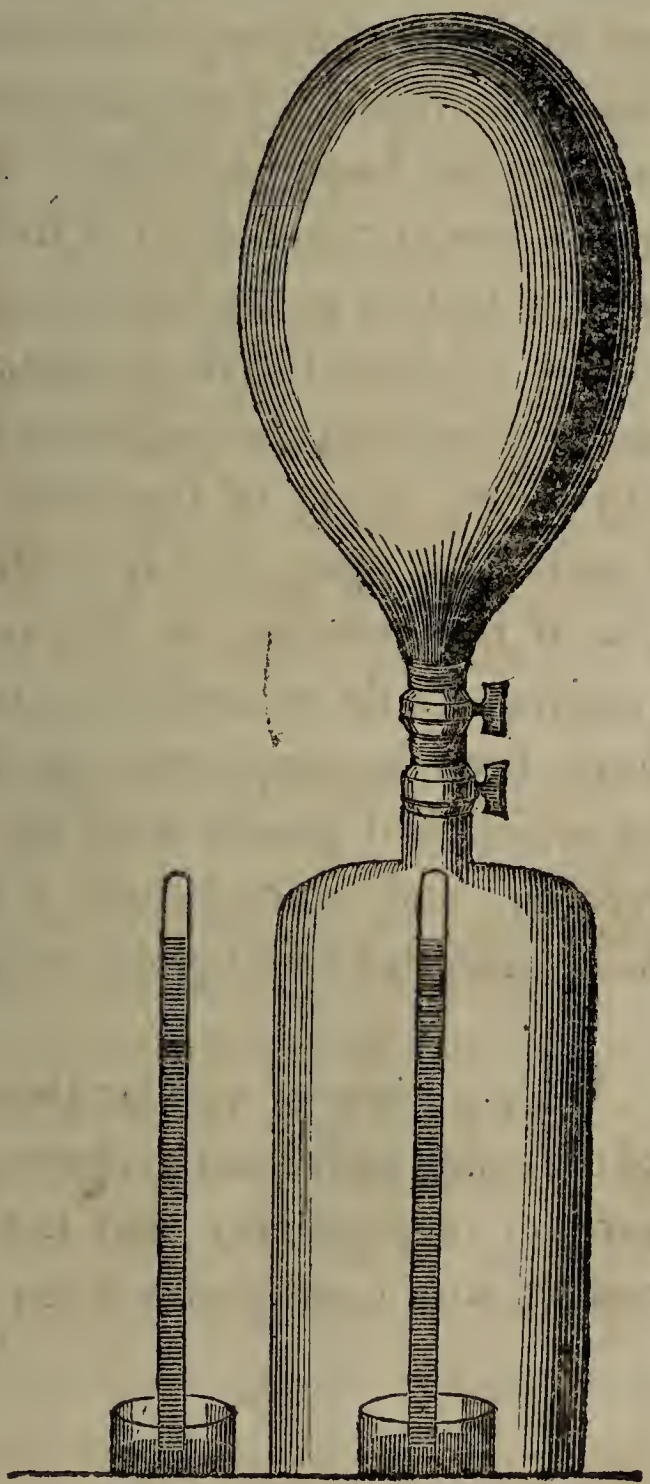
I A closed receiver placed over the small cylinder, which cuts off the communication with the atmosphere, when making the experiment of bursting the bladder, the atmospheric column, as it is called, then resting upon the large receiver.



On exhausting the air out of the cylinder, the bladder, with which it was covered, burst with as much facility by the force of those ten grains of air, as it does when exposed to the influence of the whole weight which it is supposed the column of atmosphere exerts on the surface. If weight therefore, be the cause, of which the bursting of the bladder was the effect, it must inevitably follow, that this effect was accomplished from the weight of the air between the cylinder and the receiver, and which before was ascertained to amount to ten grains only. On

placing, however, a weight over the bladder, not of ten grains, but of eighteen pounds, it was found capable of supporting it, without suffering any lesion whatever.

2dly. In order to prove that it is not the *weight* of the atmosphere, which causes the elevation of the mercury in the Torricellian tube, more than it occasioned the depression and rupture of the bladder over an exhausted cylinder; I immersed the open extremity of a Torricellian tube in a basin of quicksilver, and placed a receiver over it; in the top of the receiver, a screw was inserted, with a stop-cock attached to a bladder, which had been previously filled with common atmospherical air, as nearly as possible of the same dimensions with those of the receiver itself; the



volume of air amounting to 2 feet, the weight of which might amount to 30 grains. The whole apparatus, therefore, consisted of a Torricellian tube filled with quicksilver in the usual way, placed under the receiver.—On exhausting the air out of the receiver, the mercury in the tube immediately sunk to the same level as the mercury in the basin. By turning the stop-cocks, the air which the bladder contained immediately passed into the receiver; the effects of which were rendered evident, by the alteration which the mercury in the basin underwent; the mercury which before was at the bottom of the tube, at the same level with that in the basin, immediately ascended in the exhausted and unresisting medium which the Torricellian tube contained, to the elevation of 29½ inches, being of the same level as one exposed to the open air. It must, therefore, follow, that if the elevation of the mercury under the receiver was the consequence of weight, it must have been accomplished by the weight of the air which had passed from the bladder into the receiver, and which before I had ascertained to have amounted to 30 grains only.

With a view of varying these experiments, and of obtaining additional evidence, that it is the pressure of expansibility and not the pressure of weight, which air exerts when the equilibrium is

destroyed, as is the case in exhausted media in general; and in the Torricellian vacuum, as it is improperly called, in particular; I took equal and separate portions of different gases, whose relative weights are known to be different from each other. I inclosed each gas separately in each bladder, and screwed the bladder as before to the receiver in which the Torricellian tube was placed; one bladder contained hydrogen gas, 2nd, oxygen gas, 3rd, atmospherical air, and 4th, carbonic acid gas; the tubes were of the same lengths, but the bores were different; varying in size, from $\frac{1}{8}$ of an inch, to 1 inch in diameter. On exhausting the air which the receiver contained, the mercury in all, sunk at the same time from 29$\frac{1}{2}$ inches to the same level as the mercury in the basin: on admitting each gas to each tube, it was uniformly found, that neither the difference in the weight of the gas, nor the difference of the bore in the tube, produced any difference whatever in the elevation of the mercury. It was found that pure hydrogen gas, which is considered to be 13 times lighter than atmospherical air, was able to raise the mercury from its level in the basin, to 29$\frac{1}{2}$ inches, equally and as rapidly as either the oxygen or atmospherical air, and more especially as the carbonic acid gas, which is the most ponderous of the whole; and that the size of the tube, and consequently the quantity of mercury in it to be raised made no difference whatever; the mercury in the smallest tube did not rise faster

or ascend higher than the mercury in the largest. Although I had not the means of pushing the experiment to a greater length, than that of raising 30lb. weight of mercury, with four pints of hydrogen gas, which do not weigh 2 grains, I have every reason to believe that these 2 grains weight of hydrogen gas would be capable of elevating, and of preserving in a state of suspension to the height of 29 inches in an exhausted tube, a quantity of mercury of the greatest magnitude. To those, indeed, who are not disposed to ascribe the elevation of the mercury in an exhausted tube, or water in exhausted pumps, to the expansible power of the external air, I would recommend these to ascertain the fact by the easiest of possible means. It may be proved by simply placing two instruments, improperly called *barometers*,[1] under different states of atmospherical influence; the one under a glass

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[1] Properly speaking, a barometer is a measurer of weight only, and consists of a pair of scales with a weight in one balance, with a view of measuring the pressure of weight produced by the matter contained in the other; and the barometer, as now constructed, may be employed for the same purpose; it may be employed also as an excellent measure, for ascertaining the relative effect produced by weight, and the pressure produced by expansibility, as well as between the relative degrees of expansible pressure, which are exerted by different gaseous fluids. In every case, the degree of elevation of the mercury in the tube will be the sum of the pressure produced.

receiver from which the external air is entirely excluded, containing any quantity of air, say 2 cubic feet, weighing 25 or 30 grains; the other in open space, exposed to the influence of the whole atmospherical column; it must evidently follow, that if the elevation of the mercury in the tube be caused by weight, by the pressure of weight of the atmosphere; the mercury in the tube of each instrument ought to undergo unequal degrees of elevation; so far, however, from the elevation being unequal, the mercury will be found to preserve the same parallel in both. The elevation of the mercury to the same parallel in two instruments, placed in situations so totally different from each other, either proves the absurdity, that equal effects can be produced by unequal causes,—or that the weight of 25 or 30 grains can accomplish as much as the whole incumbent weight which the atmosphere is falsely supposed to possess: if the receiver, with which the first instrument was covered, be removed, and exposed to that supposed weight, the mercury within it continues unaltered. The conclusion, therefore, presses upon the mind with force irresistible, that the elevation of the mercury in the Torricellian tube, and the various degrees of elevation and depression which it undergoes, are not caused by the weight or gravity of the air; and that the weather-glass now in general use, called barometer, from βάρω μετρον, a meter or measurer of weight, is called, by a term which is irrele-

vant and improper; but that the term *ana-plometer*, from the compound word αναπλοω μετρον, a meter or measurer of expansibility, ought to be substituted for it. So far, therefore, from the barometer measuring the degree of pressure which the atmosphere exerts by its weight, it is by its expansibility alone that the atmosphere acts; pressing with the greatest force when it is least ponderable; and, when it is most ponderable, exerting the least pressure; that is to say, that it is most expansible when least ponderable, and least ponderable when most expansible.

It was objected to these experiments that the atmospheric column, as it is usually called, pressing by its weight, upon the outside of the bladder, was the cause of the mercury rising in the tube, and therefore, that the experiment was inconclusive. To obviate this objection, I procured a glass vessel, about eight times the size of the receiver, furnished with a stop-cock, and made perfectly air-tight,—and after having exhausted the receiver, I fixed the vessel to it, in a way similar to that in which the bladder was fixed. By this means the atmospheric pressure, *was completely excluded.* Upon turning the stop-cock, the air which the bottle contained, expanded and filled the receiver equally with it; the mercury rose to within about *one eighth* of its regular elevation; the reason why it rose no higher is obvious:—the air within the glass vessel, was di-

vided between the receiver and the bottle together, which, being as above stated, about one eighth of its capacity, the expansive power of the air within it was weakened one eighth, and therefore could only raise the mercury in that proportion. I afterwards repeated the same experiment with hydrogen gas, and obtained exactly the same result.

I then condensed the air within the glass vessel, by adding about one eighth to it, so that when the communication was made between it and the receiver, the contained air was of the same density as the surrounding atmosphere,—the result was that the mercury was elevated to its proper height: and by pushing the experiment to a greater extent,—by condensing a double quantity of air in the glass vessel, and afterwards opening the communication with it and the exhausted receiver, it was found that the mercury, in the exhausted tube, was raised proportionably high.[1] The plate annexed is the instrument I employed.

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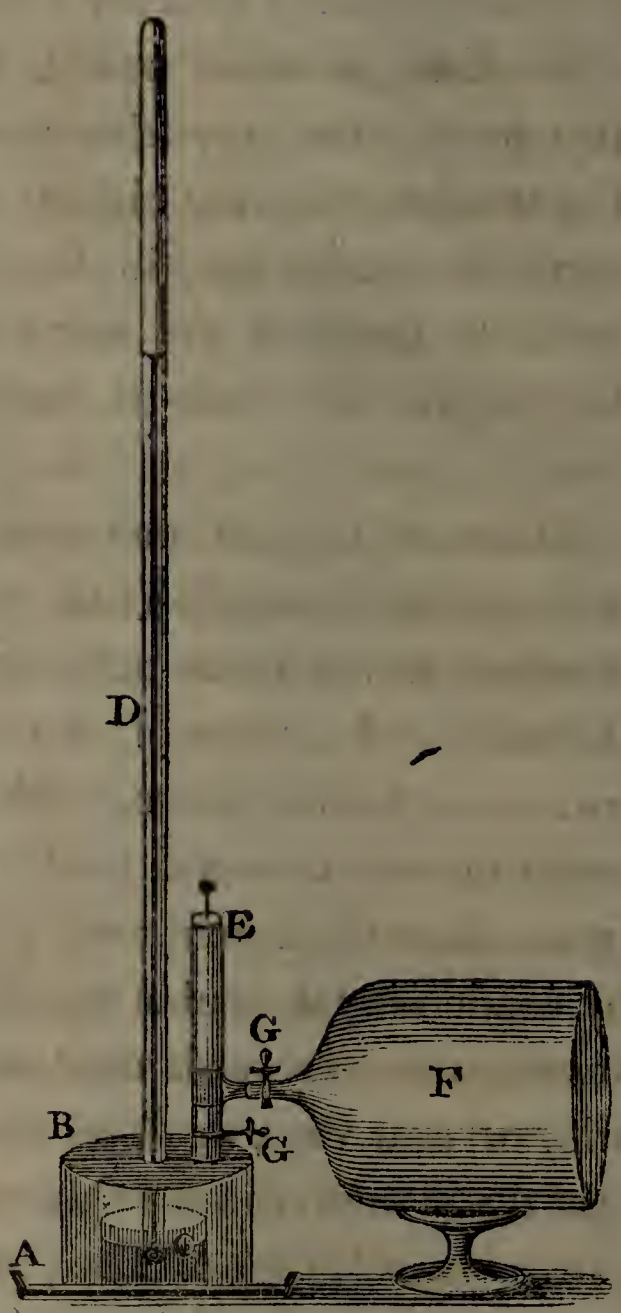
[1] I am particularly happy, in having the present opportunity, of expressing the obligation which I owe to Mr. Knight Spencer, Secretary to the Surry Institution. The mechanical knowledge which he possesses, his ability in conducting experiments, and his zeal in the pursuit of science, have been of essential service to me, in conducting these and other experiments: and proving by the evidence of facts, the truth of the deductions which I had made, from the principles I had established.

A The plate of the air pump.

B A small glass receiver, with a brass top fitted air-tight.

C The bason to hold the mercury.

D The barometer tube, thirty-six inches long, fitted air-tight into the brass top of the small receiver B.



E A forcing syringe with a stop-cock G, fitted air-tight into the brass top of the small receiver.

F A glass vessel with a stop-cock G, made air-tight, and fitted into the syringe E, communicating with the small receiver B, having about 8 times its capacity.

G Stop-cocks to cut off the communication with the large glass vessel F, whilst exhausting the small receiver B.

Another objection having been made, namely, that by all these gases being generated, under the full weight of the atmosphere at the surface of the earth, it was owing to this weight, that this expansible force was so much increased; in order to obviate this silly remark, (as if weight could generate expansibility in non-expansible bodies) I determined to get hydrogen gas made under the receiver, after it had been completely exhausted, and to which the external air could have no access. Mr. Spencer, with his accustomed expertness, easily accomplished it. Iron filings were immersed in a cup of water, close to which was placed sulphuric acid, in a saucer with a spout. The air within the receiver, in which the Torricellian tube was placed, was then exhausted, and the mercury sunk down as before in the bason. By tilting the table on which the apparatus was placed, and mixing thereby the acid with the filings of iron and water; hydrogen gas began instantly to form; which suddenly expanding in every part of the receiver, caused an apparent agitation in it, as well as on the surface of the mercury, which immediately began to rise from its low level, in the bason, and in two minutes to fill the whole of the Torricellian tube.

In order to see the effect of ice and of fire, upon the expansible power of air; we immersed

the jar full of atmospheric air in a quantity of ice, and after leaving it several minutes to cool, we opened the communication between it and the exhausted receiver. (The mercury in the tube was on a level with the mercury in the bason; thermometer in the open air was 58-$\frac{1}{2}$, barometer 30-$\frac{1}{10}$.) The expansive force of the air immediately raised the mercury to 25-$\frac{6}{10}$ inches, which was nearly the same height as the atmospheric air had done before, when the thermometer was 58-$\frac{1}{2}$.

We then immersed the outside of the same jar, when full of atmospheric air, in boiling water, and on the air being admitted into the exhausted receiver, as in the former experiment; we found its expansive force considerably increased; instead of raising the mercury to 25-$\frac{6}{10}$ inches, it raised it to 32-$\frac{3}{10}$ inches.[1]

We poured into the jar one ounce of filtered water, and exhausted the air out of the jar as completely as it was possible: that the exhaustion was complete, we found, by opening the communication with it and the exhausted receiver, that

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[1] It must be remarked that although this heat was considerably lighter than before, its expansible force was considerably increased.

the mercury did not rise in the least perceptible degree; we then exposed the jar, thus exhausted of air, to the influence of the solar rays, from 8 A. M. to 2 P. M. thermometer 60, barometer 30 four-tenths, wind N. E., sky very clear; we then exhausted the receiver, containing the barometer, and opened the communication between the jar and the receiver: the mercury instantly rose to 27 four-tenths inches.

We then filled the jar with common atmospherical air, and repeated with it, the above experiment; the mercury, however, did not rise in the tube so high by one inch. Whilst the former experiment proved the formation of gas by the action of the solar rays upon water, it proved also that the gas thus formed was more expansible than the atmospherical air, and that it had the power of raising the mercury in the tube as high as the whole atmospheric column.[1]

It was owing to the errors which I have detailed of measuring the power of air by its weight, instead of its expansibility, and of subjecting to the same

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[1] It ought to be recollected that the air, by being divided between the jar and the receiver, could not elevate the mercury so high, as it is when it is confined to the receiver alone, as observed p. 83. As I do not enter into a chemical discussion of the subject, I forbear stating, at present, the chemical quality of the gas that was thus formed.

laws bodies whose nature and properties were totally different from each other, that a great proportion of the false philosophy of the present day is to be ascribed; it was in subservience to this false philosophy, of measuring air by weight, that Mr. Boyle himself, so deservedly esteemed for every quality that was great and good; in order to account for the rise and fall of the mercury in the anaplometer, by the known changes which the atmosphere undergoes; concluded, that the weight of the atmosphere was greatest when it was most serene and clear; and, on the contrary, that it was most light, when most thick and cloudy and charged with vapors; that is to say, that it was most heavy when it was most light, and most light when it was most heavy;—the mercury rising in the former case from 26 to 30 inches; and, on the contrary, settling in the other from 30 to 26 inches.

It is far otherwise, in wet weather. There is in the atmosphere, more water but less air, and in dry weather, there is more air, but less water: during the former state, the atmosphere has more weight, but less expansibility; during the latter, there is more pressure from expansibility in every direction, and less pressure in a particular one from weight.

To illustrate false principles by false facts, and

to reconcile contradictions by natural phenomena, it is necessary to prove, what has been asserted by the wise, and is believed by the credulous and the ignorant, that air when dry is heavier than when it is moist and wet.[1]

In order to ascertain the truth or error of this assertion, I instituted a series of experiments, which were performed by an experienced and skilful teacher of experimental philosophy, the result of which decidedly proved, that when the atmosphere was moist and wet, it was considerably heavier than when it was dry, and vice versa; when we reflect that the relative density which water bears to air, is nearly in the proportion of 1000 to 1: the gravity of wet air, more than such as is dry, appears a self-evident truth. So far, therefore, from supposing that the increased elevation of the mercury in the Torricellian tube pro-

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[1] It ought to be observed, that the mode, generally employed to ascertain the weight of air, by confining it in a bottle, under an exhausted receiver, does not convey any idea of the real power of air; for if the bottle, in which the air is confined, be broken, and the air let loose, the apparent weight which it possessed when inclosed by the bottle, is at once lost—instead of falling and precipitating downwards, it dilates from a centre to a circumference equally in every direction:—Vide Chap. 6, on the Gravity and Levity of Gases.

ceeds from an increase of weight in the atmosphere, I feel justified in drawing a conclusion which is totally opposite. I, on the contrary, conclude that it proceeds from increased expansibility and diminished weight, and that the depression of the mercury in rainy and stormy weather, is occasioned by a decreased expansibility of the atmosphere, although there exists in it an increase of weight.

The diminution in the expansibility of the atmosphere, often takes place for some time, before it becomes cognisable to our senses. It is not only indicated by the concavity of the surface of the quicksilver in the anaplometer, but by its actual depression; and it is to be presumed that the change is so felt by different animals, from the alteration which takes place in their usual habits. Observation has reduced to a proverb, that whenever ants quit their work, and swallows fly close to the plane surface; whenever bees keep within the hive, and rabbits in their burrows, a change of weather, from dry and serene, to wet and stormy, is about to ensue.[1]

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[1] Sir G. Staunton, in the history which he has given of the Embassy to China, furnishes us with a very striking illustration of the depression of the mercury in the anaplometer, when the atmosphere changes from an expansible to a ponderable, from a dry to a wet state. Nothing, he observes, could

It only remains for me to show, that when these variations of elevation and of depression in the quicksilver in the anaplometer takes place, they

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be more pleasant and uniform than the navigation from Java to Sumatra; on approaching the coast of Africa, the atmosphere, from being bright and serene, became overspread with clouds, the wind changed from N.E. to S. W., the mercury in a marine barometer, so suspended as not to be affected by the motion of the ship, fell suddenly more than one fourth of an inch; the depression of the fluid in the former part of the voyage had not exceeded one tenth part, and yet that small change had always been followed by a correspondent change in the weather. So certain a prognostic on every occasion, that it was daily consulted. In the present instance when the fall was so much greater, than before remarked, inconsiderable alarm was excited. Great precautions were taken against the impending storm, which seemed to approach rapidly. Scarcely was all snug, when the tempest burst, with one of the most tremendous crashes of thunder and lightning ever known. The air was likewise *so dense*, that one end of the ship was not visible from the other, the rain fell in torrents, there was no wind, Vol. iii. p. 448. Although this instrument cannot always be depended upon, there is nevertheless, considerable truth in it. I was assured by a very intelligent officer, who commanded a ship, which formed one of the unfortunate India fleet, four of which foundered with all on board, off the Cape of Good Hope, that he ascribed to it the preservation of his own ship on that melancholy occasion. On getting up from table after dinner, he examined, as was his constant practice, his marine barometer, and was struck with the sudden and excessive depression which the quicksilver had undergone. Although it was then perfectly calm, and the sky quite serene, he im-

are accompanied by correspondent changes in the hygrometer also. Whenever the hygrometer indicates dryness, the mercury in the anaplometer rises and is high; on the contrary, when the former indicates moisture, the mercury in the other sinks and is low. Those who have not made observations on these various changes, may consult the different volumes of the Philosophical Transactions; in which the corresponding variations in each instrument are distinctly marked, and it will be found they agree with what I have detailed.

Having, I trust, established the physical properties, which belong to the atmosphere, and the mode and the manner by which these properties act; the elevation of the mercury at the surface to a high point is easily understood; whilst this

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mediately ordered the small sails to be taken in, the top-gallant masts to be struck, and every thing else to be properly secured against the impending storm; the work had scarcely been completed when clouds began to form, flashes of lightning the most vivid ensued, accompanied by torrents of rain, and one of the most dreadful tempests ever experienced, Vide Chap. xviii. p. 348. On *Colorification.* Chap. xix. p. 385. On the Decomposition of Atmospheric Matter and the Formation of *Rain,* and Chap. xx. On *Comets,* or the means by which the Matter of one System is prevented from interfering with the Matter of another.

elevation is occasioned by the increased degree of expansible force, which the atmosphere there possesses; so the progressive fall, which the mercury undergoes in ascending high mountains, is referable to the diminution in the expansive force of air, in consequence of increased dilatation, in a manner precisely similar to the depression, which it undergoes, when it is placed under the receiver, and when the air is gradually exhausted out of it.

If time permitted it, I should be happy to pursue this important subject through its various details, and to expose the radical and palpable errors, which, I feel persuaded, abound in our present system of natural philosophy. I have taken pains to detect those errors, and to put the subject on its true footing, in the book which I have lately published. I defy any man to contradict the facts, which I have advanced in it, or the deductions which I have drawn from them. I challenge him to the contest, and if his observations are entitled to any notice, I engage to give him an immediate reply.

The End.

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